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Popular Mechanics

SCIENCE TECHNOLOGY AUTOMOTIVE



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PAGE 28

101 GADGETS

COLLECTORS' EDITION

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HISTORY.

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Team America lets 'em fly at L'International des Feux Loto-Québec in Montreal last July.

50 101 Gadgets That Changed the World What do the smartphone, Walkman, brassiere, fishing reel and blender have in common? Each, in its own way, has transformed our lives. PM's expansive cover story celebrates the most ingenious, unusual and groundbreaking gizmos of the past two centuries. **BY THE EDITORS**

72 Kaboom! Spectators at an annual fireworks competition in Montreal marvel at the bone-shaking detonations and pyrotechnics that paint the sky. But before the big show, teams toil for months to design and build the bombs. PM explores the art, science and drama of one very explosive contest. **BY CHRISTOPHER MAAG**

76 Four-Wheeling West Virginia The flatter and straighter the road, the more boring the journey. The highways, byways and backwoods trails of the Mountain State? Not boring. We hit (and diverge from) the road in the Jeep Grand Cherokee Overland to find the state's hidden riches and quirky charm. **BY EARL SWIFT**

86 Lessons From Japan Experts consider Japan's disaster planning and infrastructure the best in the world. But as recent history shows, some catastrophes can overpower any preparation attempt. PM visits the island nation's devastated coast to learn what we can in the aftermath of the historic event. **BY CARL HOFFMAN**

On
the
cover

Of the millions of gadgets invented since 1800, a mere handful have emerged as profound cultural forces. In a joint project with HISTORY and a panel of experts, PM ranks the 101 most influential gizmos. **Illustration by Dogo.**

PHOTOGRAPH BY **LEON CHEW**

DEPARTMENTS

In Every Issue

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Tech Watch

13 Private Space Gets Heavy The world's most powerful rocket is being built—but not by NASA. **Plus:** An expert addresses the top misconceptions about radiation; robot submarines help solve the mystery of Air France Flight 447's crash location.

Upgrade

25 YourIdeaRules.com The Switch Modular Pocket Knife: A regular guy's idea becomes a real product via quirky.com. **Plus:** We put water guns through the wringer, give away a Triumph cruiser, test a compact drill and dial up a 3D phone.



Carl Strong takes a break in his Bozeman, Mont., bicycle shop, Strong Frames.

New Cars

35 Godzilla Gets Fiercer Nissan's GT-R cranks up the power. **Plus:** The new Zero DS electric bike.

Columns

46 Timeless Cord The 1937 Cord 812 was an early adopter of many auto advances, such as front-wheel drive and hidden headlights. Jay Leno takes the measure of a masterpiece.



'I consider myself a craftsman foremost,' says bicycle builder Carl Strong. 'I want a frame to look good, but I never do any adornment that doesn't add to the bike's performance.' — *This Is My Job*, page 132

On the cover

50 101 Gadgets That Changed the World 72 The Ultimate Fireworks Competition 109 11 Fuel-Saving Driving Tips 28 Win a \$14,000 Cruising Bike

PopMech
diy



Home

93 Your Table Is Ready Build PM's marble-top coffee table for hundreds less than retail, and your cup will rest in style.

98 Homeowners Clinic Mind our midseason mower checklist for a good-looking yard all summer. **Plus:** The right way to install CO detectors.

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106 PM Saturday No power? No problem. Bake delicious treats using the sun's heat with our Hot-Box Solar Oven.



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109 Saturday Mechanic With historically high gas prices, every mpg counts. We give you 11 easy steps to save money at the pump.

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119 Making 3D Movies Want to make your own stereoscopic film? We tell you what to buy and how to shoot it, view it and share it.

122 Digital Clinic Why hotel TVs are so annoying. **Plus:** How to text using Wi-Fi.



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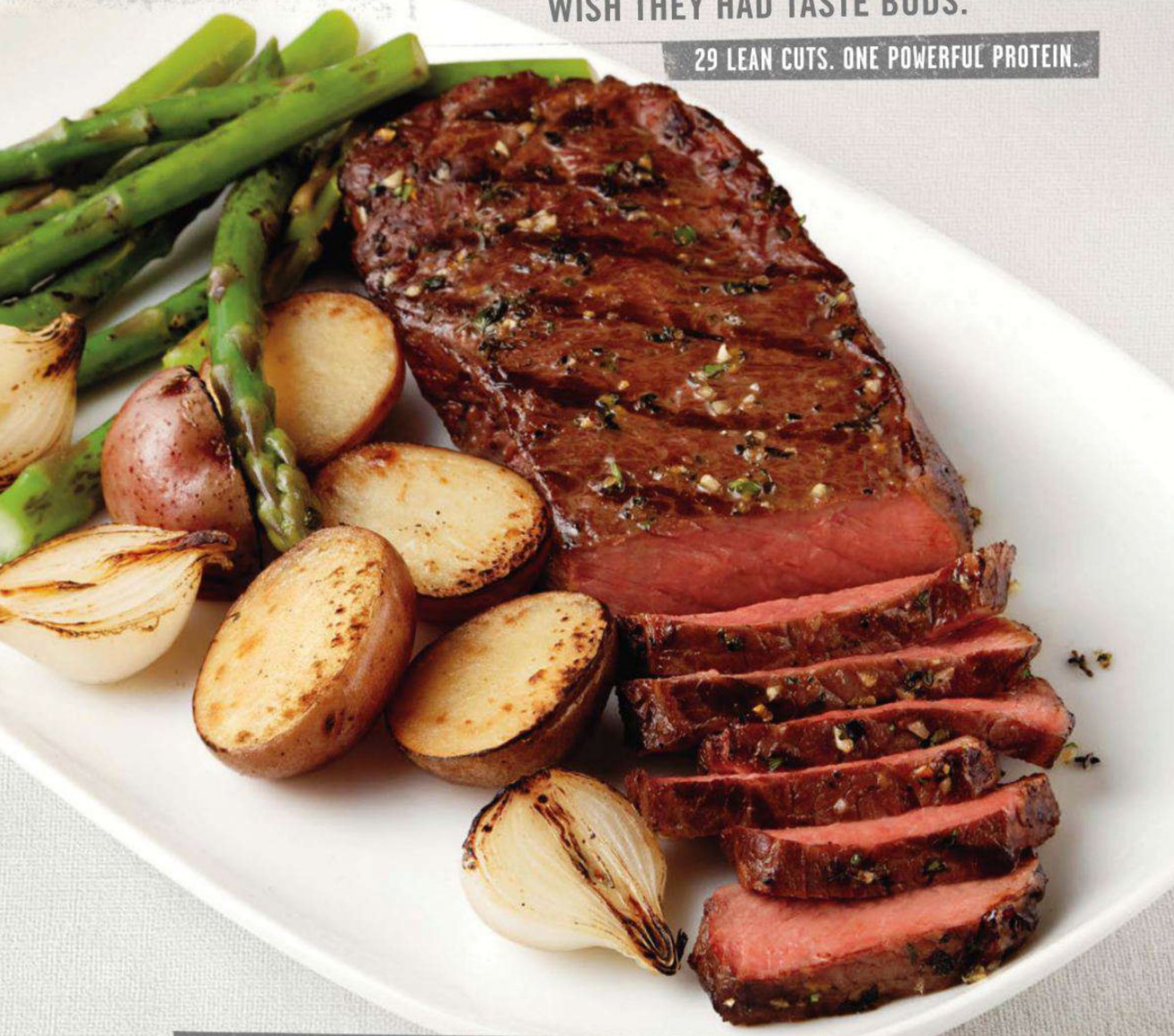
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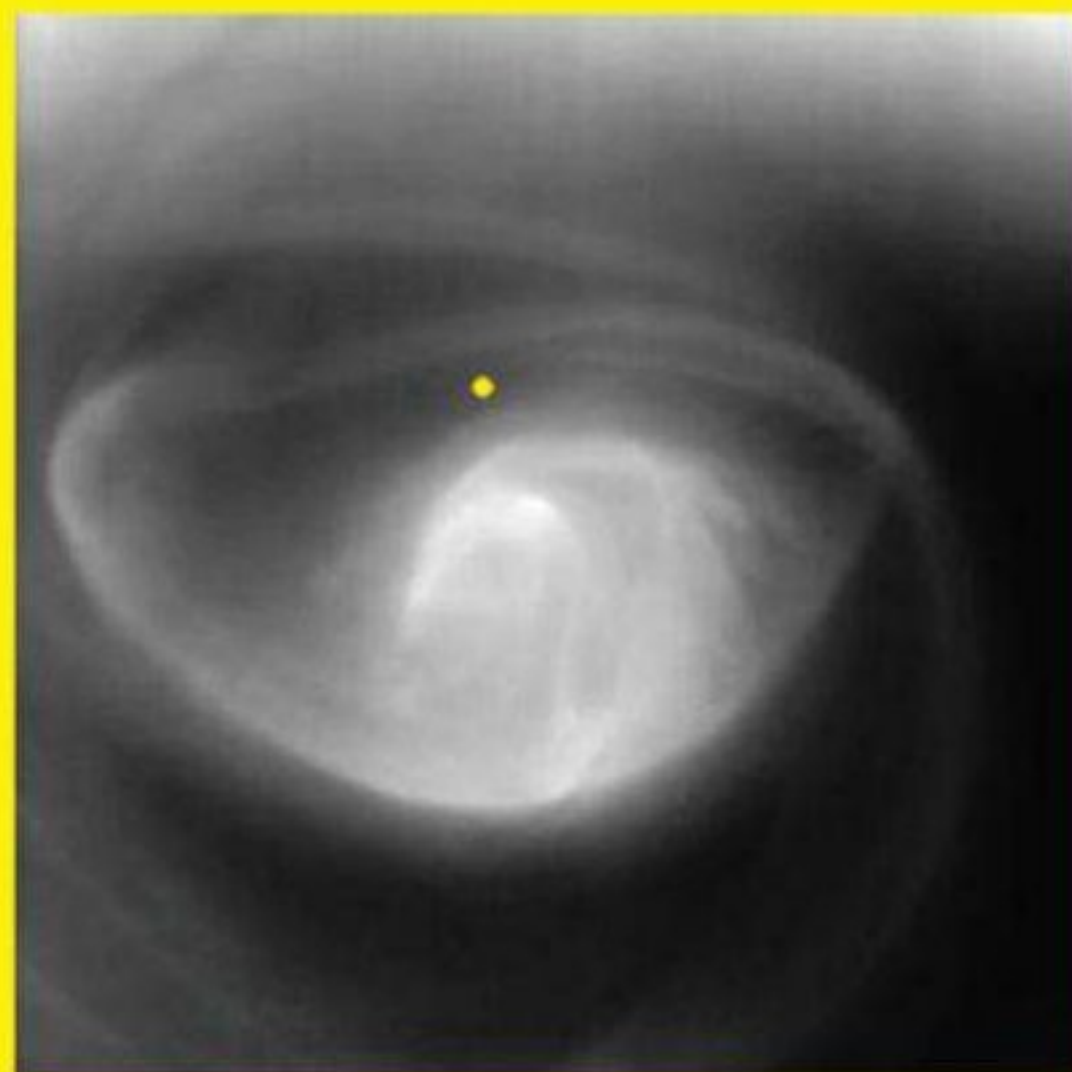
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X JULY

SPACE WEATHER Methane rain falls on the deserts of Saturn's moon Titan; mysterious hurricanes swirl on Venus (below); and Jupiter's belt of dark clouds suddenly goes missing, only to reappear just as inexplicably. It's all part of the extreme forecast from around the solar system. Earth isn't the only world with wild weather swings.

popularmechanics.com/spaceweather



WAVE POWER There may be 10 trillion watts in the waves just waiting to be tapped. These five designs—inspired by oysters, aircraft and more—could help capture the power of the ocean.

popularmechanics.com/wavepower

HEAVY LIFTING We take a look at the anatomy of the Falcon Heavy, the newly announced heavy-lift rocket by SpaceX that ups the ante for commercial space launches and could send large payloads (and people) to the moon or even Mars.

popularmechanics.com/spacex

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Wanted: Automotive Innovation

I just finished reading your May article "Fifteen Ways the Indianapolis 500 Changed the Way You Drive" and found the article informative—but the topic a little sad and disappointing. The most recent dates these innovations occurred were in the mid- to late '60s. All the rules and regulations placed on the cars' design and engineering seem to have leveled the playing field. I'm a mechanical engineer, born in the '80s, and I wish that the spirit of innovation was still as vital now as it was in past years of Indy racing. This type of stuff shouldn't be old news—it should be happening now.

ADAM SCHETTLER SHERMAN, TX

EDITOR'S NOTE: Your point is well-taken. Unfortunately, there's no easy explanation of why Indycar tech hasn't changed much in recent years. One partial answer has to do with dollars and cents: As the sport of auto racing matured, the cost of finding a technological advantage rose to the point where only a few wealthy teams could pursue it. I also think Nascar has had an influence; that hugely popular series proved that the vast majority of fans want close competition rather than one high-tech car that laps the field. Meanwhile, innovation in a relatively new motorsport, electric-motorcycle racing, is evolving quickly. You might want to check it out.

LARRY WEBSTER, AUTOMOTIVE EDITOR, POPULAR MECHANICS

A Vote for Essential Deterrence

The following is a response to a letter from PM reader Gordon Edwards that appeared in the May issue. After reading the March feature "Down in the Hole," Edwards wrote that he felt our nation's nuclear defense system was outmoded and an unnecessary use of tax dollars. Is Mr. Edwards suggesting we should only be spending money on defense systems that would be used? If so, I think he misunderstands the concept of deterrence. The missiles at our nuclear stations today were a significant tool in maintaining peace during the Cold War. While the relevance of our nuclear arsenal may have decreased somewhat since the collapse of the Soviet Union, we still need to keep up a strong

defense to show we're ready to respond to a threat, should one arise.

JOHN MCPHERSON SEATTLE

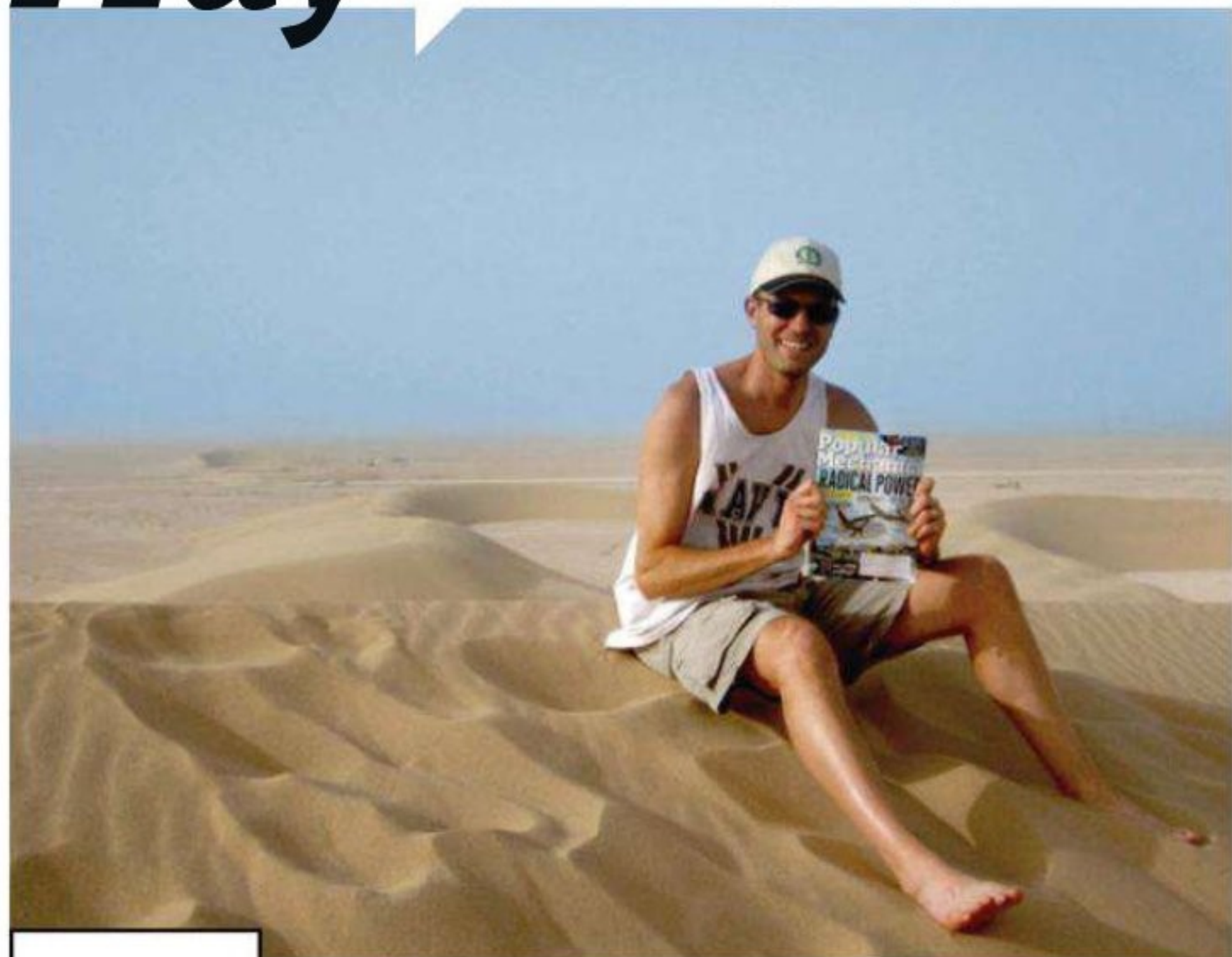
Robotics Sparks a Reaction

I was excited to see the FIRST Robotics supplement. I recognized people I admire from the featured teams, and writer Erik Sofge did a great job explaining the dedication required to keep the competition alive.

FELIPE AGURTO (FIRST ROBOTICS MEMBER, TEAM NC GEARS) FREMONT, MI

May

Barry Leslie of Okotoks, Alberta, uses PM to teach his students in Doha, Qatar, about science—but only after he has read it, as seen here among the "singing" sand dunes.



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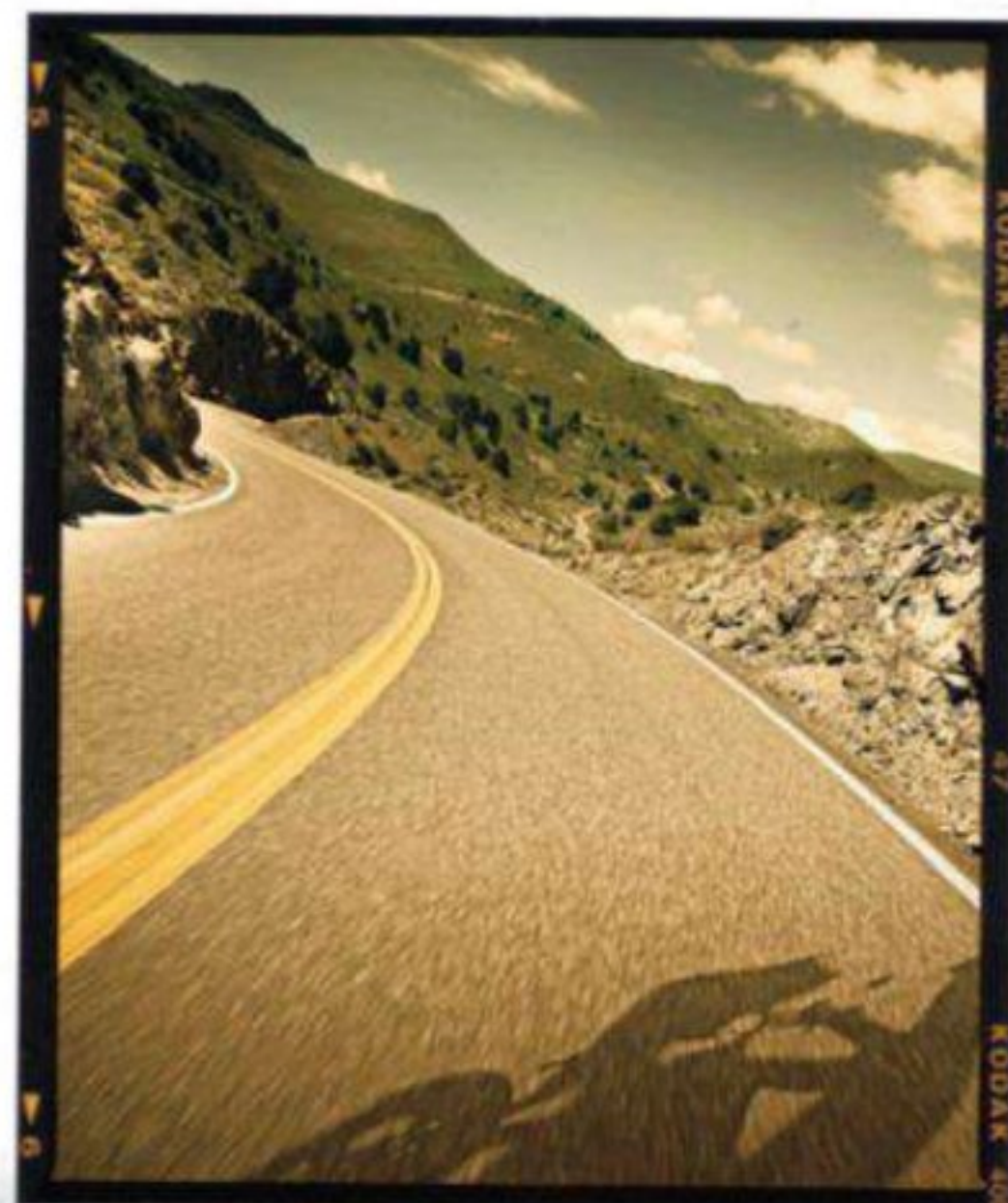
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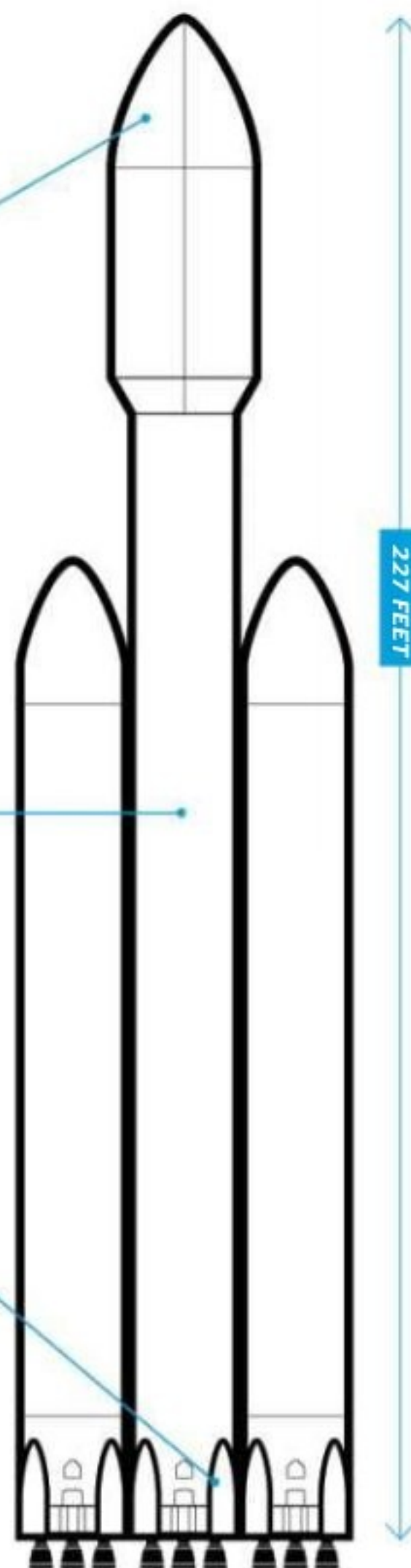
Private Space Gets Heavy

→ The world's most powerful rocket is being built—but not by NASA or any other government space agency. Hawthorne, Calif., startup Space Exploration Technologies (SpaceX) says its Falcon Heavy rocket may be ready for its maiden flight by the end of next year. — MICHAEL BELFIORE

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• QUICK HITS

NATURAL POWER

• Researchers at MIT claim to have invented the first practical "artificial leaf." The playing-card-size device, when placed underwater in direct sunlight, splits water molecules into oxygen and hydrogen, which could then be stored in a fuel cell to produce electricity. A single leaf, already 10 times more efficient at cleaving H₂O than a real one, should provide enough daily power

for one house in the developing world. Unlike previous artificial leaves, the new one utilizes inexpensive materials: silicon plus nickel and cobalt catalysts. Considerable challenges remain, though, including figuring out how to capture the gases.

— ALEX HUTCHINSON

BRAVE, CLEAN AND ROBOTIC

• The Boy Scouts of America recently released a new merit badge in



robotics. Scouts must design, build and demonstrate their own robot to earn the badge, which displays one of NASA's Mars rovers. "I think it's awesome," Steve Squyres, the scientific principal investigator for the Mars Exploration Rover mission, tells PM. "Now we know we've arrived."

— JOE PAPPALARDO

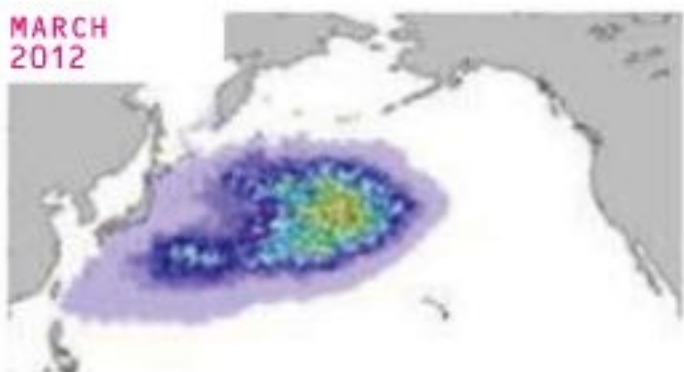
A PUNCHING BAG THAT HITS BACK

• An amateur inventor in Australia has created a training robot for boxing that can dish it out as well as it can take it. The humanoid Punching Pro uses three 12-volt windshield-wiper motors to throw punches at a boxer. The robot can hook and jab at several speeds, or it can go into "berserk" mode by adding an extra axis of rotation to the attacks. Creator Kris Tressider hopes to turn the prototype into a commercial product retailing for less than \$1000. — A.H.

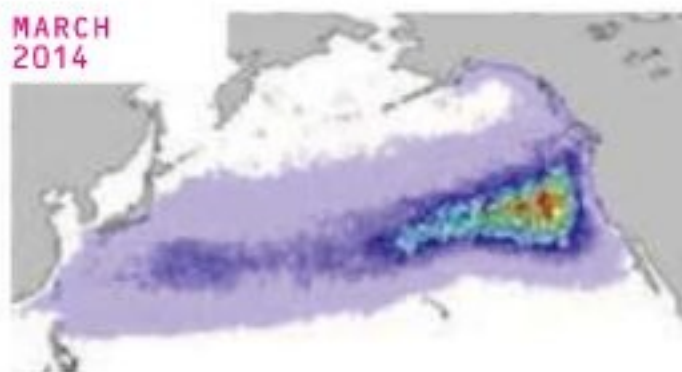
MARCH 2011



MARCH 2012



MARCH 2014



THE LONG REACH OF A TSUNAMI'S FLOTSAM → The debris washed into the ocean by Japan's devastating tsunami is drifting across the Pacific Ocean. Researchers at the University of Hawaii, Manoa, using data compiled from research buoys, calculate that the first pieces will reach Hawaii next year, but it will take until 2014 before the wreckage arrives on the West Coast of North America. — A.H.



DRONE LIFE: Like workers in cubicles, honeybees trained to respond to the scent of explosives take a shift as sensors in a prototype detector.



Laser Beam Telegrams

➔ Forget fiberoptics—the quickest way to send large amounts of data over long distances is through the air with a laser. In principle, laser beams bounced off an orbiting satellite could send 100 gigabytes of data per second and reach anywhere on Earth—or the solar system. While all previous attempts to create free-space optical communication systems have encoded information by varying the intensity of the laser—amplitude modulation (AM)—scientists at Stevens Institute of Technology in New Jersey recently figured out how to send data by varying the frequency of the laser. This frequency-modulating (FM) signal is less sensitive to disruptions from fog, dust and rain. The researchers are now seeking ways to increase data speed.

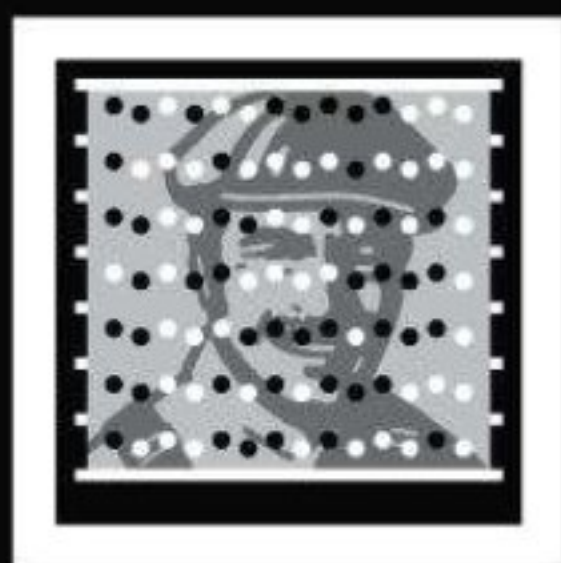
• EMPLOYMENT FOR INSECTS **Bees vs Bombs**

Some researchers are willing to enlist strange allies in the quest for public security. Inscentinel, a startup company funded by the British government, created a bomb-detection device that uses 36 honeybees to sniff out explosives. First, the bees are trained to associate the scent of common explosive compounds, such as Semtex, TNT and C4, with food. (The training takes only minutes.) The team of bees is then attached to tiny sensors. Each bee holder faces an infrared LED. If a bee detects explosives, it extends its proboscis to feed, essentially sticking its tongue into the IR beam. If enough bees do this at the same time, it triggers an alarm. The company's prototype, a handheld device about the size of a DustBuster, reportedly outperformed current detection technology in British tests, picking up vapors with part-per-trillion sensitivity. Company officials say the bees are returned to their hive after their shift. — ALEX HUTCHINSON



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Plumbing the Depths of Disaster

Air France Flight 447 disappeared off the Brazilian coast in June 2009 with 228 people on board, leaving little but questions behind ("Anatomy of a Plane Crash," December 2009). French aviation authorities needed to find the wreckage, especially the plane's black boxes, to figure out what happened. Only problem: The impact site lay somewhere beneath a 90-mile-wide expanse of ocean. The French called on

their military and international oceanographic researchers to deploy submarines and an array of remotely operated vehicles. But the most powerful subsurface assets proved to be three Remus 6000 autonomous underwater vehicles, or AUVs. These torpedo-shaped robots can travel up to 22 hours at a stretch, systematically scanning the seabed with sonar that images a half-mile-wide swath with every pass. "The only way you're going to be able to find an aircraft in deep water is by using this type of wide-area survey capability," says Dominique Rissolo, executive director of the Waitt Institute, the nonprofit organization that owns two of the AUVs used in the search. After two years of on-and-off searching, AF 447 remained lost. So the authorities revised simulations of ocean currents and looked in a new area. Just a week after reaching the new search zone, a Remus AUV launched from the vessel *Alucia* (below) found the wreckage, 13,000 feet down. — JEFF WISE

THE SEARCHERS

Here are three submersibles that took part in the hunt for the doomed Airbus A330-203:

EMERAUDE

Type: French nuclear-powered attack submarine
Maximum rated depth: 1600 feet
What it did: Listened for pinging of black box acoustic beacons
Sensors used: Hydrophones, sonar

REMORA 6000

Type: Remotely operated vehicle
Maximum rated depth: 20,000 feet
What it did: Recovered black boxes
Sensors used: Scanning sonar, CCD camera

REMUS 6000

Type: Autonomous underwater vehicle
Maximum rated depth: 20,000 feet
What it did: Searched and identified wreckage on the seafloor
Sensors used: Side-scan sonar, camera with strobe



In April, the cameras of the Remus 6000 (1) first spotted AF 447's wreckage (2). Soon after, a Remora 6000 underwater robot (3) found and recovered the flight data recorder (4).



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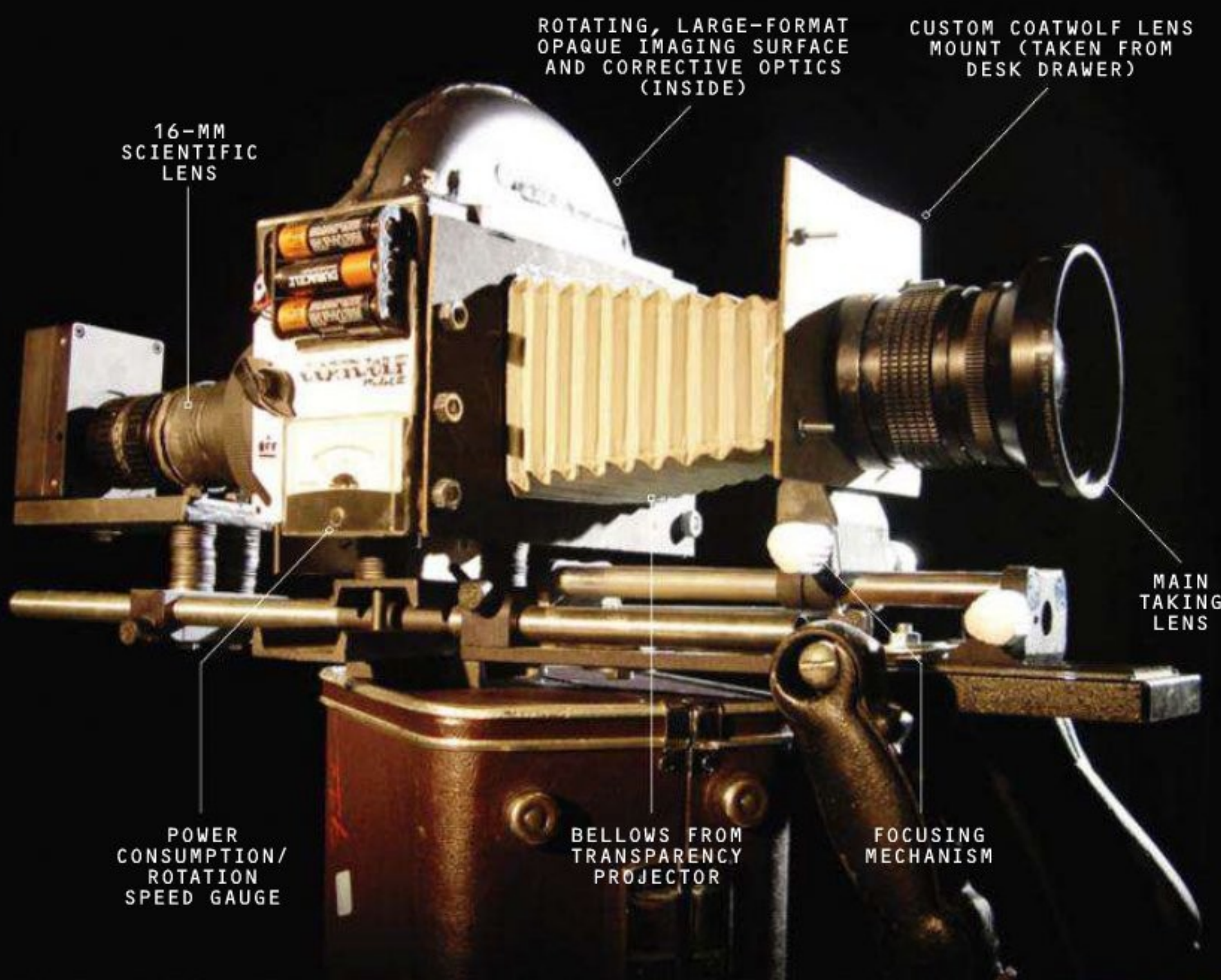


ELEMENTAL CONTROL

Lifesaving Wizardry



➔ **Harvard chemists are fighting fire with electricity.** Building on the knowledge that electric fields can affect the shape of flames, researchers connected a wand to a 600-watt amplifier—comparable to a car stereo system—and experimented with ways to manipulate a foot-high blaze. The device's electric fields subdue or bend the fire by attracting or repelling carbon soot particles, electrons and ions inside the flames. The researchers envision portable electric fire extinguishers that can carve escape routes for victims, and ceiling-mounted systems that can suppress flames without damaging rooms with water or foam. — A.H.


**GLODELL'S
COATWOLF
MODEL II
CAMERA**
The Adapter

Glodell constructed a 35-mm ground-glass adapter, which focuses an image on a screen between the external and main lenses, to create a very shallow depth of field.

The Lenses

Glodell wanted to shoot on a 4 x 5-inch plate—twice the size of IMAX film—so he needed large-format optics. To get them, "I ripped apart old projectors and spyplane surveillance lenses that I bought at an Army surplus store."

Extreme Closeup

When it came time for Evan Glodell to direct his first feature film, *Bellflower*—about two *Mad Max*-obsessed friends who prepare for the apocalypse by building flamethrowers and battle-ready cars—he wanted to shoot on a large-format camera, one so big that it didn't yet exist. So he constructed it himself. "I've built things my whole life—I can't help tinkering," says Glodell, who also wrote and starred in the film, in theaters Aug. 5. It took him a month of R&D to build his 20-pound camera, the Coatwolf Model II. Glodell's only training was a week of engineering classes in college, but that didn't deter him: He also built *Bellflower*'s flamethrowers and turned a 1972 Buick Skylark into the film's fire-breathing Medusa-mobile (right). "I never stop building," he says. "It seems like it happens naturally." — ERIN MCCARTHY


The Effect

"There was this huge trial-and-error process," Glodell says of the camera. "I kept switching parts until I got something that looked cool." The resulting shots—some tilt-shifted, some partially blurred and some narrowly focused—give *Bellflower* a unique cinematic look.

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• NEWS ANALYSIS

Spies at War

IN RESPONSE TO THE ATTACKS ENGINEERED BY OSAMA BIN LADEN, THE CIA LAUNCHED A NEW ERA OF AGGRESSIVE ACTION. THE CHANGES BIN LADEN TRIGGERED KILLED HIM—AND WILL ENDURE. — JOE PAPPALARDO

The killing of Osama bin Laden was a seminal moment for the Central Intelligence Agency. Now, with the successful completion of the mission, there is heightened public debate about the changes within the agency that led to bin Laden's death.

Officials say it took 45 minutes to conduct the raid that killed bin Laden. Actually, his violent demise began the week after 9/11. On Sept. 17, 2001, the White House authorized the CIA to conduct "targeted killings" of al-Qaida personnel, overriding the ban on political assassination first approved in 1976 by President Ford. Later in 2001, Congress also signed off on this approach by declaring war on al-Qaida. The dual policy shifts meant a new, violent role for the CIA. Al-Qaida was agile and transnational, and so the hunters had to be as well.

After nearly 10 years of conflict, the CIA attacks militants wherever the White House chooses. Missile attacks by CIA-operated unmanned aerial vehicles in Pakistan are now fairly routine, and the method has been applied in Yemen and Somalia. Snatch-and-grab renditions span the globe, as do secret facilities

where detainees are interrogated. This is, indeed, a new kind of war. "What you're seeing now is an evolution, and it's predicated on the threat environment we face," says Frank Cilluffo, former White House special assistant to the president for homeland security. "During the Cold War, it was spy versus spy. There were some small, hot wars, but it was country on country. The threats today are very different."

The CIA has authorization to kill people, but it doesn't have a deep bench of trigger pullers on its payroll. In the past the agency hired proxies, either local fighters or contractors, to conduct some operations, but there are missions too difficult and vital to delegate to hired hands. At such times, the CIA uses experts from the Joint Special Operations Command. The team that killed bin Laden, the Naval Special Warfare Development Group ("Team Six"), was formed to rescue hostages, not conduct targeted killings. But the skill sets overlap.

The relationship between the CIA and the special-ops community has never been closer, thanks in part to

shared operational experiences in Afghanistan and Iraq. But this comfortable collaboration has drawbacks, especially among the super-secret military units that operate within the CIA's more tolerant culture. In 2009 the Congressional Research Service noted that the agency's covert operations "can often be contrary to international laws or laws of war that U.S. military personnel are generally expected to follow." In 2005, a Navy SEAL was court-martialed for his role in the death of a CIA detainee during interrogation in Iraq. The SEAL was acquitted. CIA personnel were not even named.

This mission was high-risk; don't expect similar raids to end equally well. There are good reasons why the CIA handles the vast majority of its covert killings in the war on terror by firing missiles from unmanned aircraft: These attacks are lethal and one-sided. They bring war to the enemy leadership hiding in ungoverned areas of Pakistan, not just foot soldiers who cross the border into Afghanistan.

But CIA airstrikes also cause civilian casualties that incite the Pakistani population and inflame domestic backlash. The alternative, face-to-face gunfights, risks operator lives and the exposure of the U.S. government's actions. The bin Laden operation, one of the most meticulously planned in black-ops history, was jeopardized when a helicopter crashed. "These are complex missions," Cilluffo says. "And then there's serendipity."

A militarized CIA may come at a price. The Obama administration's selection of Gen. David Petraeus to head the CIA reflects the close relationship between the CIA and the Pentagon. While some say Petraeus is the right choice for that reason, others worry about an overall loss of focus. The fear is that long-term strategic analysis may be sacrificed for short-term tactical information to be used against terrorists. "You hear it from intelligence analysts when you interview them," says Jennifer Kibbe, who studied the issue in the journals *Foreign Affairs* and *Strategic Intelligence*. "They are too busy with what's happening right now to focus on what's coming down the pike."

It was just such a lack of strategic thinking that blinded agency personnel to the threat of spectacular terrorist strikes against the U.S. homeland—which bin Laden exploited in 2001. **PM**

EXPERT VOICES The Truth About Radiation



THE PUBLIC'S REACTION TO THE NUCLEAR DISASTER AT JAPAN'S FUKUSHIMA-DAIICHI POWER PLANT BORDERED ON HYSTERIA. A LEADING EXPERT IN THE FIELD SHARES SOME FACTS THAT ARE BEING LOST IN THE MEDIA COVERAGE.

MYTH

All radiation is equally dangerous.

REALITY

→ Many reports present radioactive contamination in stark terms: You're either exposed or you're not. But the type of radiation and whether it's been inhaled or swallowed determine its health risk. Fukushima released emitters of beta particles and gamma rays. Beta particles injure organs only if ingested or inhaled; gamma rays penetrate skin to cause internal damage.

The power plant will become a Chernobyl-like wasteland.

→ Dire predictions about the scope of the cleanup abound. But the extent of the contamination depends on the kind of radioactive material and how much escaped—still a subject of investigation. One of the isotopes, iodine-131, largely will decay after 80 days (10 half-lives). But cesium-137, which has a 30-year half-life, was also released. It could be months or years before authorities consider the area safe to inhabit.

Every radiation detector measures the same thing.

→ Some TV reporters with radiation detectors jumped to on-air conclusions about the risk of exposure. But they often used Geiger counters, which can tell how much radiation is present but not the intensity of the energy it deposits. Other gear, such as ion-chamber detectors, can measure dose by counting the ions produced by radiation as it passes through air. This is a better measure of the risk posed by the radiation.



Andrew Karam has been working with radiation and radioactivity since 1981, when he enlisted in the Navy. Karam has served as a radiation safety officer at University of Rochester and as a consultant with the International Atomic Energy Agency. He is currently a consultant on radiation safety. This spring, Karam traveled to Japan to gather information on the crisis.

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Upgrade

YourIdeaRules.com

→ The **Switch Modular Pocket Knife (\$79)** stows 18 attachments in a case as compact as a socket wrench set, letting users create a custom multitool suited to the task at hand.

The implements are flimsy—expect to get more use tightening screws than sawing lumber. What sold us on the gizmo is the story of its creation. Like everything on quirky.com, the Switch came from the mind of some ordinary guy. Anybody with a product idea can upload it to the site, where users help tweak the final design. Almost 400 people worked on the Switch, and the collaborators receive a cut of the sales. So, if you've got a big idea—imperfect though it may be—now is the time to bring it to life. — **SETH PORGES**



Bean Buster



↑ Good coffee grinders usually hog countertop real estate; cheap ones can pulverize beans into overheated dust. The **Bodum Bistro Coffee Grinder (\$100)** is a fine compromise—14 settings for coarseness, a slight 7 x 7 x 12-inch profile and an eye-catching design in five colors. Whether you store it away or show it off, keep it close by for the next cup.

Clean Up

← Stairs are tough work for a vacuum. It takes a step-by-step effort to set up the machine for 2 square feet of cleaning. An attachment to the bagless upright **Electrolux Nimble HEPA Vacuum (\$300)** engulfs the risers and treads like an alligator's jaws, allowing stairs to be cleaned with ease.



Call in 3D

et ready for the glasses-free-3D avalanche. Fresh off the success of Nintendo's 3DS game system, countless companies are hustling to market with their own takes on the tech. One we're actually excited about: the **HTC Evo 3D Phone (price not set)**, which features a 4.3-inch glasses-free 3D display. And while it won't have the 3DS's preloaded stash of 3D games, the Android-powered device does feature a pair of 5-megapixel cameras for shooting 3D photos and HD video.

Rediscover Duke → In the pantheon of lost cultural artifacts, **Duke Nukem Forever (\$50)** sits somewhere between the Beach Boys' *Smile* and the last J.D. Salinger novel. After 14 years of delays, false starts and lawsuits, finally getting access to the finished product feels like catching a unicorn. But does the new *Duke* deliver? The game's fans have probably grown up a bit in the years since *Duke Nukem 3D* arrived in 1996, but Duke himself is still exactly the same: a cigar-chomping, bazooka-firing, shades-wearing action hero. The result is a hilarious, violent and unapologetic product that should remind more than a few gamers of simpler times in the mid-'90s. This ain't *FarmVille*—as Duke would say, "Come get some."





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MARLON BRANDO RODE A 1950 TRIUMPH THUNDERBIRD—

not a Harley—as a skew-capped outlaw in 1953's *The Wild One*. Now you can ride the iconic motorcycle's modern equivalent, the 2011 Thunderbird Storm. Some things have changed in 60 years: Today's bike has two headlights that burn brighter than a candle, and the oil pan isn't prone to nocturnal emissions. Other updates include a supple front suspension, which helps the 746-pound cruiser corner nicely. The coil-over rear shocks also smooth out the ride. But the machine is still a classic where it counts—the 1700-cc engine retains a parallel-twin layout, and the black leather, chrome details and bucket headlights look perfect for the kind of guy ready to rebel against, well—whaddya got? Win, and you've got a \$13,899 bike. Enter at popularmechanics.com/triumphsweeps. — HARRY SAWYERS

POPULAR MECHANICS TRIUMPH THUNDERBIRD STORM SWEEPSTAKES Random draw sweepstakes. No purchase necessary to enter or win. Sponsored by Hearst Communications, Inc. Beginning June 7, 2011, at 12:01 am (ET) through July 15, 2011, at 11:59 pm (ET), go to popularmechanics.com/triumphsweeps to complete and submit the entry form pursuant to the online instructions. Odds of winning will depend upon the total number of eligible entries received. Must be a legal resident of the 50 United States, District of Columbia or Canada who has reached the age of majority in his or her state, territory or province of residence at time of entry. Void in Puerto Rico, in the Province of Quebec and where prohibited by law. Sweepstakes subject to complete official rules available at popularmechanics.com/triumphsweeps.

GEAR UP



Dainese Dyno Shoes, \$200:

Dynos are as full-featured as riding boots, with a thermoplastic shell, an armored toe and tuck-away laces. But because of their short rise, they're also made for walking.



Aerostich Electro-Touch, \$57:

Electro-conductive stitching lets a rider tap an iPhone or a GPS touchscreen without having to strip off these rugged elk-skin gloves.



Dainese Alien Jacket, \$700:

Aluminum armor inserts protect the back, chest and elbows; engineered leather resists tears; and the classic, trim look suits a Triumph's style.

+ MOTORCYCLE MAYHEM, SUMMER 2011

Wing Ding 33

→ The annual gathering of the Gold Wing Road Riders, a crew of Honda Gold Wing and Valkyrie bike owners, revs up July 6 to 9 in Knoxville, Tenn.

Beartooth Rally

→ A 120-mile trip through the 10,000-foot Beartooth Pass—and a hand of seven-card stud—caps this Montana rally July 15 to 17.

RMC's 97th Birthday Bash

→ The Reading Motorcycle Club, one of America's oldest, hosts drag races, biker church and other family fun July 28 to 30 in Oley, Pa.

Across the Border Raid

→ Bedford, Iowa's Harley club throws one hell of a party Aug. 4 to 6. The raiders ride across the Missouri state line—and then come back.

Back-to-the-Basics

→ Hog riders of Concord, Vt., roast a hog, then review the basics of Harley burnouts, bike games and bonfire craft Aug. 12 to 14.

Ride With the 40

→ Honoring the 40 heroes of Flight 93, the ride stretches from San Francisco to the memorial in Shanksville, Pa., Aug. 29 to Sept. 8.

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The world of water guns is in an all-out arms race. In a test of four new weapons, nobody made it home dry—but our soggy notes helped determine which tools could dish out the most devastating deluge. *BY ERIK SOFGE*



Nerf Super Soaker Thunderstorm (\$15)



Water Warriors Gorgon (\$25)



Nerf Super Soaker Hydro Cannon (\$25)



Banzai Aqua Tech Transmopher (\$20)

Ballistics

To test accuracy and range, we shot a 3-foot-high target from increasing distances until the gun failed to wet the mark.

THUNDERSTORM: Shot 25 feet. Powered by a battery, it's easy to shoot but weak.

TRANSMOPHER: An inaccurate trigger-free, pump-action mechanism fired 27.5 feet.

HYDRO CANNON: A series of giant spray bursts traveled 35 feet but required 10 to 20 bicep-burning pumps between shots.

GORGON: Ten to 15 pumps generated enough pressure for sustained, accurate fire over a 30-foot range.

Ammunition

We compared capacity by clocking the time it took to fire off a full tank, then averaged five reload times at a spigot.

THUNDERSTORM: The 10-ounce tank emptied in 46 seconds and reloaded in 19.84 seconds.

TRANSMOPHER: The 5-ounce tank uses only 4 ounces effectively. It goes dry in just 28.3 seconds and reloads in 21.46 seconds.

HYDRO CANNON: This 40-ounce tank shot for 2:28 and took 33.7 seconds to reload.

GORGON: This 108-ounce monster gushed for 2:56. A top-mounted port is attached to a spigot to refill in 24.1 seconds.

Combat

Our embedded correspondent documented a brutal water battle among 5-, 10- and 12-year-old neighbors.

THUNDERSTORM: The portable clip and pump-free firing made this gun the favorite, despite a comparably weak shot.

TRANSMOPHER: The small tank proved difficult to keep filled in the heat of battle. It was a hit until the ammo ran dry.

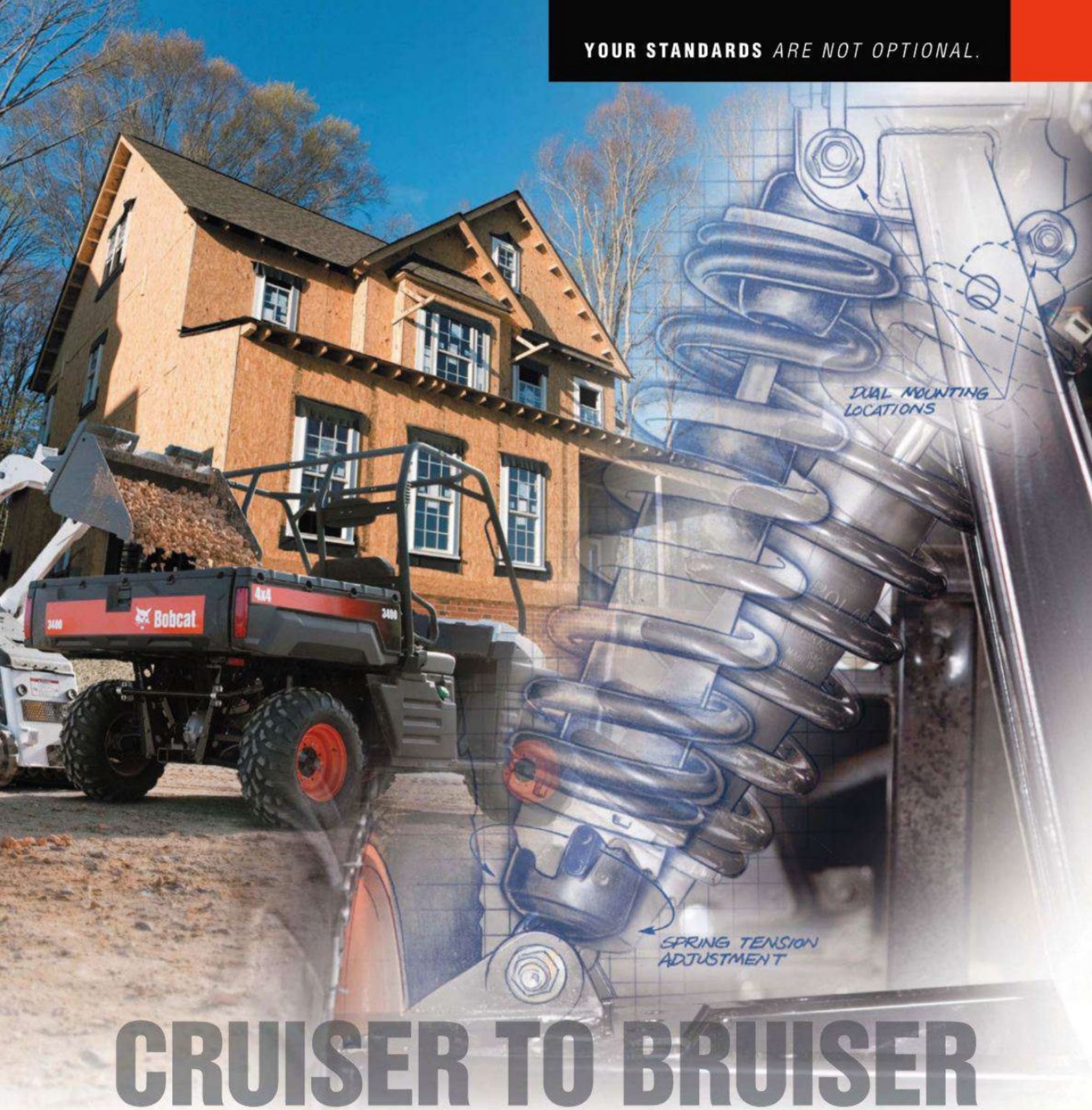
HYDRO CANNON: A powerful but bulky weapon "not easily concealed for a battle," as one tester put it.

GORGON: This gun's giant tank was too heavy for even the oldest tester, and the pump-fire was hard to shoot on the run.

BOTTOM LINE

The Hydro Cannon and Gorgon won by the numbers, but when the mist cleared on the battlefield, the kids preferred the easy battery-powered firing of the compact Thunderstorm. That gun and the Transmopher are the best toys for young combatants. For older aquatic assailants, the Hydro Cannon and the Gorgon have the range and power to hose targets in an ambush or a shootout.

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UPGRADE



Work an Angle

The drill may be the world's most versatile power tool, but working with the traditional gun-like architecture in a tight space can be awkward. Right-angle drills provide a close-quarters solution, but they're typically underpowered. The **Milwaukee M18 Cordless Right Angle Drill (\$229)** packs enough oomph to mount a junction box to a stud—even without the aid of a pre-drilled pilot hole.

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→ Small-time entrepreneurs from furniture builders to landscapers now have a way to expand sales beyond cash-only transactions. The **Square Mobile Credit-Card Reader (\$10)** swipes cards via a scanner plugged into the headphone jack of an iPhone, iPad or Android device. The hardware and app collect 2.75 percent of each transaction. Visa, MasterCard, American Express and Discover charges sync with the user's bank account upon setup, and there is no limit on the payment amount a vendor can accept. The Square app emails a receipt to the customer, creating a record of the transaction—and taking a step toward revolutionizing how a sole proprietor can run a small business.



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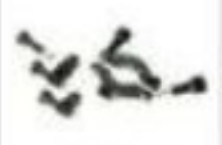
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New Cars

Godzilla Gets Fiercer

Nissan's GT-R didn't earn its "Godzilla" nickname for qualities that would suit a Lexus; this relentless tarmac eater would never let niceties like chassis refinements or sound deadening impede its epic performance goals. But the 2012 GT-R's updates





include suspension tweaks that reduce understeer, increase feedback and allow for more balanced handling, as we discovered while piloting the four-seater through several hundred miles of Los Angeles roads. Lest you suspect Nissan's flagship has lost its edgy appeal, consider the engine mods that boost the twin-turbocharged V6's output to a tire-spinning 530 hp while managing a 1- to 3-mpg improvement in fuel economy. The sprint to 60 mph now arrives in a scant 3.2 seconds, which trumps Porsche's 911 Turbo. Godzilla's ride is still bone-shaking, and its automated dual-clutch six-speed transmission groans and clunks like a rusty barn door, but this bad boy's speed-hungry target audience wouldn't have things any other way. — BASEM WASEF

2011 Aston Martin Vantage S



AD-VANTAGE ASTON ▶ The least expensive Aston, the Vantage, also happens to be the best-driving of the company's rapidly expanding lineup. This year, the firm enhanced the S version with more than 40 significant changes. In addition to a mild horsepower bump to 430, there's a new seven-speed automated manual transmission that bangs off full-throttle shifts like an F1 car. In fact, the entire Vantage S feels like a racing car. On a 1.5-mile track near Las Vegas, we pushed the car as hard as we could—watching the digital speedometer creep as high as 120 mph and sliding the tires in the tight turns, stomping on the brakes as if we were killing cockroaches—and only once did we feel as if we might lose control. After we got a feel for the car's limits—which are incredibly high—only one demerit emerged: the \$138,000 price. — JOE BARGMANN

The Sound of Silence

▶ Zero's 2011 lineup—now five bikes strong—reveals how rapidly the electric-motorcycle field is maturing. Nearly completely redesigned for 2011, these lithium-ion-battery-powered bikes feature increased range and a quick-charger that can top off the battery in about 2 hours. The slight, 297-pound curb weight of the dual-purpose DS model (\$9455) makes it extremely flickable, while new steel-braided brake lines and a bigger front rotor offer more feel and stopping power. Above 30 mph, it whisks itself effortlessly through space while emitting only a slight motor whine. But range is still the DS's *bête noire*: We ran only 43 miles before the battery went flat. — BASEM WASEF

Aluminum frame

2011 Zero DS



4.4-kwh lithium-ion battery pack

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Practical Exotic

► Ferrari has finally answered the question that few have ever asked: How do you get a Ferrari to the ski slopes? So, now we have not only the first Ferrari 4x4, but also the first series-produced Ferrari hatchback. (Otherwise, where will the skis go?) The FF also breaks convention with its all-wheel-drive system, which powers the front wheels via an innovative gearbox that's hooked to the front of the V12. The result is an impressive degree of maneuverability on snow, and the system can play other tricks by selectively engaging to reduce understeer and correct oversteer. It's still, however, a superlative supercar. The 651-hp engine provides scintillating performance—a top speed of 208 mph and a jolt to 60 mph in 3.7 seconds. The result is certainly striking and practical, and is probably the fastest all-around Ferrari GT ever made. —ANDREW ENGLISH

2012 Ferrari FF

Ferrari hatchback?!

Ferrari's AWD system



2012 Honda Civic



PERFECTLY ACCEPTABLE ► The new 2012 Civic is undoubtedly better than before. It's structurally stiffer and quieter, yet no heavier. The dimensions remain mostly unchanged, but it feels roomier inside, thanks to thinner A-pillars. Plus, all versions, from the hybrid to the sporty Si, burn less fuel than the outgoing models. This car will surely continue its sales success—it's the sixth-best-selling car—and we wouldn't talk anyone out of buying one. But as good as it is, the Civic simply is not on our shortlist. Where Honda once imparted the Civic with Toyota-like reliability and refreshing, almost frisky driving behavior, the new Civic is sliding down a slippery slope to blandness. Its electric power steering lacks the road feel of the old car. Even the hot-rod Si has ditched the charismatic 8000-rpm engine for a larger displacement but slower revving engine. If you want a small, fun-to-drive Honda, get the Fit. —LARRY WEBSTER

2012 Mercedes-Benz C-Class



CLASSIER BABY BENZ ► The updates to the C-Class are more than a facelift. Along with new front and rear styling—both ends incorporate LED illumination—the car offers U.S. drivers three more powerful and efficient engines (a 201-hp 1.8-liter turbo four, a 228-hp 3.0-liter V6 and a 302-hp 3.5-liter V6), a new seven-speed transmission and a more refined interior. The steel unibody has dropped some weight, thanks to an aluminum hood. Electronic aids that help drivers stay on the road and avoid obstacles are now options. While it doesn't have a floaty or detached feel, the C-Class rides well over imperfect pavement and transmits little road noise to the cabin. The car rolls little in corners, and tracks true to the pilot's inputs. Enthusiasts looking for a fully engaged driving experience will be disappointed, but everyday drivers searching for a small luxury sedan will feel invincible. —REX ROY



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Inspired Performance

2012 Buick LaCrosse
eAssist



ELECTRIC BOOST ▶ For 2012, all LaCrosse with the base 2.4-liter four-cylinder will include a more powerful version of GM's electric hybrid boost system. In place of the usual alternator, there's a 15-hp electric motor that does double duty: It recaptures energy during braking and feeds in power to assist acceleration, both via a seven-groove serpentine belt that's routed around the engine's crankshaft. Plus, the unit enables the computer to shut off the engine at stoplights. In concert with a lithium-ion battery pack that's positioned behind the rear seats—which does take its share of cargo volume—the system boosts fuel economy to 37 mpg on the highway. That's a heady figure for this plush and roomy sedan, yet the base price remains tame, around \$30,000. — LARRY WEBSTER

2012 Toyota
Rav4 EV



THE TESLOTA ▶ Last year, Toyota invested \$50 million in Tesla, and now we have the first fruit of this budding partnership, a prototype electrified version of the Rav4 that, starting next year, will only be available to fleet customers. Behind the redesigned fascia, the V6 has been tossed in favor of a 150-hp, high-torque electric motor drawing power from a massive 660-pound Tesla-supplied lithium-ion battery pack. With 37 kwh of usable power, this chunky 3962-pound compact SUV can do 80 to 120 miles of real-world travel and quietly zip to 60 mph in about 9 seconds. Since the batteries are packed under the floor, this EV doesn't lose any passenger or cargo space and could be just the ticket for in-town errands, as long as users can tolerate the 16-hour recharge time (that's at 240 volts—don't even think about 120). — BEN WOJDYLA

People's Sedan

▶ You won't get leg cramps riding in the back of the new 2012 Passat, the sedan that VW is building at a new factory in Tennessee. Designed to compete with cars like the Honda Accord, the Passat features best-in-class rear legroom and the segment's only diesel engine, which is good for more than 40 mpg and an 800-mile range. The base powertrain is a 170-hp five-cylinder with a five-speed manual; the performance edition uses a 280-hp VR6 coupled to a six-speed automated dual-clutch gearbox. During a spin near the factory, the steering, brakes, stiff chassis and sharp handling all said German car, but the spacious cabin and the rockin' Fender-tuned audio gear spoke to our American need for long-distance, cross-country comfort.

— KEVIN A. WILSON



2012 VW Passat

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Driver Distraction



A modern F1 car has a movable rear wing, electric-hybrid boost, adjustable differential and clutch, and even dials that affect the engine's torque curve. It's the most technologically sophisticated race car on the planet, so naturally it's got an equally complex steering wheel that's jammed with enough switches and dials to make an airline pilot cross-eyed. Here's a breakdown of the controls F1 drivers constantly adjust—while battling other cars at 200 mph. **BY LARRY WEBSTER**



1 BOOST ▶ F1 cars have an electric-hybrid system known as KERS (Kinetic Energy Recovery System) that regenerates braking energy, then boosts acceleration—at the push of a button—via an 80-hp electric motor. Another feature that increases speed is the movable rear wing that flattens to reduce drag. The wing is controlled by a foot pedal.

2 LAP TIME

3 HARVEST ▶ Regulates the amount of energy “harvested” during braking. The regen system can alter the feel of the brakes, and because these guys drive with exacting precision, they’re picky about tactile feedback. This knob lets them customize.

4 DOWNSHIFT PADDLE

5 MIX ▶ Adjusts the engine’s air-fuel mixture to balance power and fuel economy. F1 cars don’t refuel during a race, but economy is still vital—fuel adds weight.

6 BITE POINT ▶ The race start is critical because the cars begin from a stop and the initial sprint is a prime overtaking opportunity. The bite point adjusts how the clutch engages as the drivers release the paddle, so they can execute a perfect launch.

7 BPF ▶ During practice starts, the driver uses the “bite point find” to record the clutch behavior. Engineers use the data to instruct the driver where to set the bite point dial.

8 CLUTCH PADDLE

9 BBAL ▶ Displays the front-rear brake balance, a critical adjustment that drivers make to fine-tune the braking performance. Most passes are done in the braking zones.

10 REVERSE GEAR

11 SHIFT LIGHTS

12 LIMITER ▶ Restricts the car’s speed to the pit-lane limit, 62 mph.

13 ENGINE PARAMETERS

14 UPSHIFT PADDLE

15 TORQUE ▶ The 2.4-liter V8 revs to 18,000 rpm and delivers north of 700 hp. That’s a handful in a 1400-pound car, so the drivers use this knob to adjust the engine’s torque curve, depending on track conditions.

16 TYRE ▶ Teams use roughly half a dozen different tires that vary in construction and diameter. This dial tells the computer which tires are fitted so it can calculate wheel speed.

17 CLUTCH PADDLE

18 DIFFERENTIAL ▶ Thanks to electronic controls, the characteristics of the rear differential can be tailored for corner entry, midpoint and exit—each with 12 settings. Frankly, we’re amazed that the drivers can detect such minute rear-end differences during cornering events that last for maybe a few seconds. But that’s why they’re paid millions.

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The 1937 Cord 812 was an early adopter of front-wheel drive and hidden headlights, but reliability problems kept this stylish car from sales success.

Timeless Cord

> BY JAY LENO
> PHOTOGRAPHS BY JOHN LAMM

T

HIS YEAR MARKS THE 75TH ANNIVERSARY OF the Cord 810/812. It was a sensation when it went on sale in 1936, and I think it's still one of the most beautiful sedans ever built. Originally intended as a "baby" Duesenberg, it was packed with advanced features like front-wheel drive; independent front suspension; a unitized body; an "alligator" hood hinged at the rear (like most of today's cars); a 125-hp, 288-cubic-inch V8 engine with aluminum heads—built by the Cord-owned Lycoming aircraft engine company—and a four-speed Bendix preselector gearbox with vacuum/electric shifting.

It had three other features that were firsts in America: the horn ring and, for improved streamlining, a covered gas cap and hidden headlights that the driver unveiled with a hand crank. For the 1937 model year, there was an optional centrifugal supercharger, good for 195 hp.

Naturally, the car was a failure.

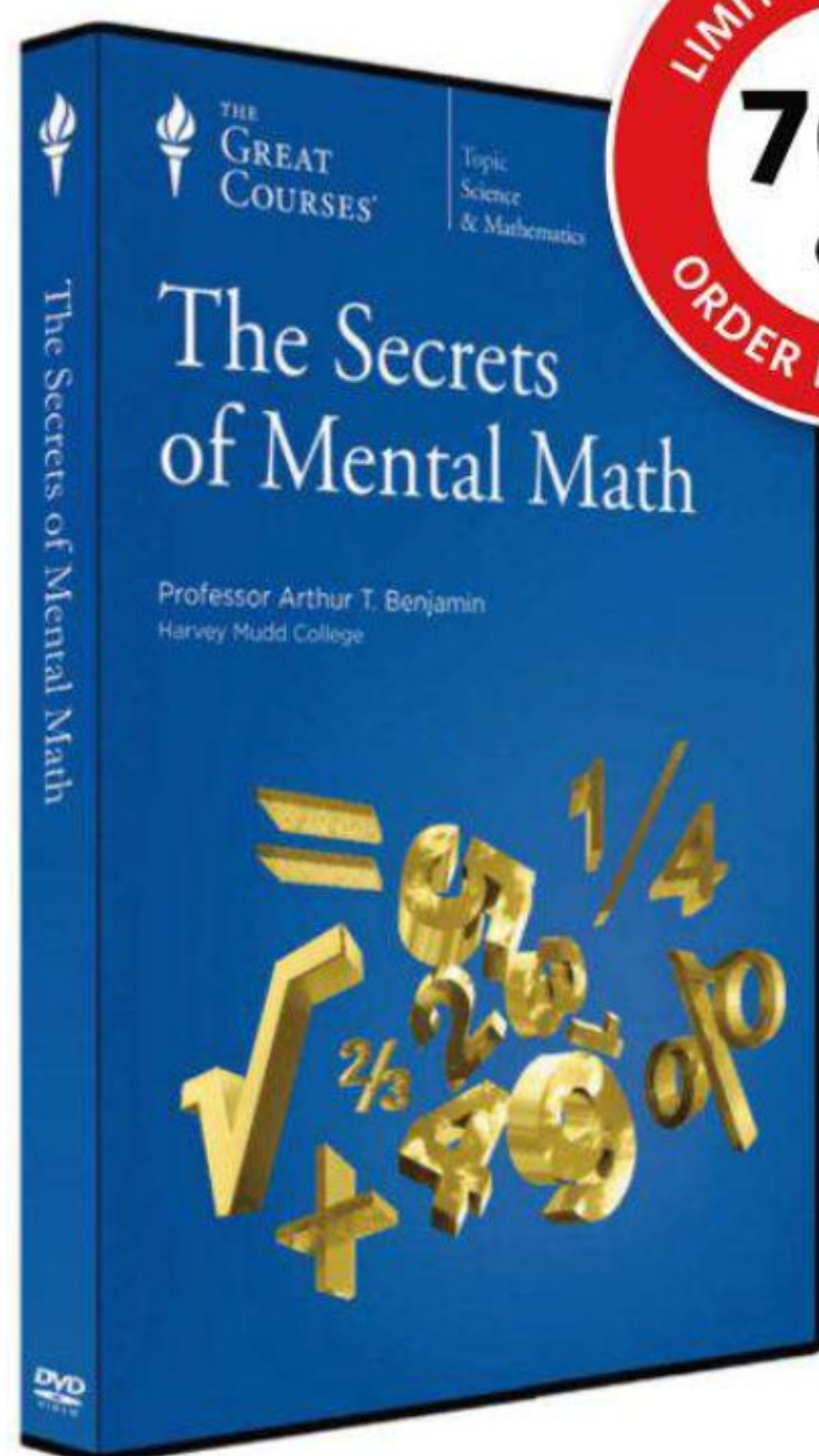
Cord didn't have the time or the money to test and tweak all these innovative systems before it went into production. Back in the day, that wasn't



uncommon, as anyone who owns an English car from the '40s or '50s can tell you. The guy at the factory would say, "You're the test driver. If you have any problems, let us know!"

That's how the Cord quickly developed a reputation for being gorgeous but unreliable. It overheated. If you left it in gear and you lost the vacuum, the transmission wouldn't shift. Most mechanics couldn't work on the car—it was complicated and unlike any other they had ever seen. If the engineers had had time for quality control and getting the bugs out, I think the Cord would have been a bigger hit.

The price tag was also an issue. At



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JAY LENO'S GARAGE ///
CORD 810/812

around \$3000, the Cord cost as much as a Cadillac, but it was way smaller. People who spent that sort of money wanted a larger car. The concept of a small personal luxury car was still 20 years away. The Ford Thunderbird was the first of those "Ooohhh, this is kinda cool, lookit this" kinds of cars.

One of the things I admire about the Cord is that the stylists and the engineers used a lot of ingenuity. They had to. The Cord was designed and built on a shoestring budget in the middle of the Depression. Here's one example: Everyone admires the Cord's wheels and hubcaps as pinnacles of art deco styling. But the simple, elegant look was a pragmatic solution to a problem. During a cross-country test drive, the brakes overheated. There was no money to develop better brakes, so the engineers later drilled holes in the full-size hubcaps to cool the brakes, and those hubcaps became one of the Cord's most admired styling elements.

The Cord factory made just under 3000 cars before production ended in August 1937; about two-thirds survive. When I was looking for a Cord, I contacted the Auburn-Cord-Duesenberg Club. I always pay a little too much, but I wind up with a car that someone has put his heart and soul into. Mine was restored by a skilled New Jersey man named Arthur Pirre. He was an excellent mechanic and a machinist—a perfectionist. Sadly, we don't have many men like him today. He worked on this car until everything was perfect, but hardly ever drove it. His joy was making it work.

I run my Cord with radial tires, and it steers and corners beautifully. The Cord is one of the best-handling cars of the '30s. In fact, it's better than most cars of the '40s and '50s. The four-speed Bendix preselector gearbox is extremely easy to use. Introduced in the early 1930s, on the Hudson and Terraplane, it was called the Electric Hand. Fourth gear is an overdrive. In Europe, companies like Wilson and Cotal made preselector

boxes for sport and luxury cars.

The transmission in my car shifts wonderfully. Using a little lever on the steering column, you select a gear, step on the clutch, and bingo! The next gear is automatically engaged. You don't have to take your hands off the wheel in a fast turn. In most cars from the '30s, you have a long stick shift that comes out from under the dash. With front-wheel drive, there's a flat floor and all sorts of room in front. Interestingly, in 1947, Preston Tucker initially used salvaged Cord gearboxes before his engineers built a similar transmission of their own.

Under the hood, the Cord's engine compartment is crowded compared with others of its era. Packing in the Schwitzer-Cummins supercharger made everything more complex. GM had stylists who designed engine compartments so that when you opened the hood on a Cadillac, you saw that beautiful V16 and everything laid out for easy access, with no exposed wiring. Not this car.

It doesn't take much to scare people away from a certain make. We're on the cusp of Fiat returning to America. But if those first 1000 cars aren't perfect, you'll start hearing all the old "Fix It Again, Tony" stories. Touted as a car of the future, the Cord was a styling tour de force. But its special features weren't fully developed and tested, and rival salesmen were waiting to exploit any flaw. It's like steam cars; a steam car has never blown up. Yet internal-combustion boosters insisted: "Oh, forget steam cars; they'll blow up." So salesmen trying to move the Cord had that bad reputation to deal with. And some rumors of problems turned out to be true.

As a classic car, my Cord is flawless. But as a car you'd use every day, I can see where you'd have some problems. You're not going to take a classic car out on a hot day; you can't leave it in gear; you only drive it under ideal conditions. In the same way, the Lamborghini Miura isn't a great driving car, especially over 100 mph, when aerodynamic forces make the car light and affect the handling. With a classic car, all those flaws are exciting—just not on a day-to-day basis.

PM



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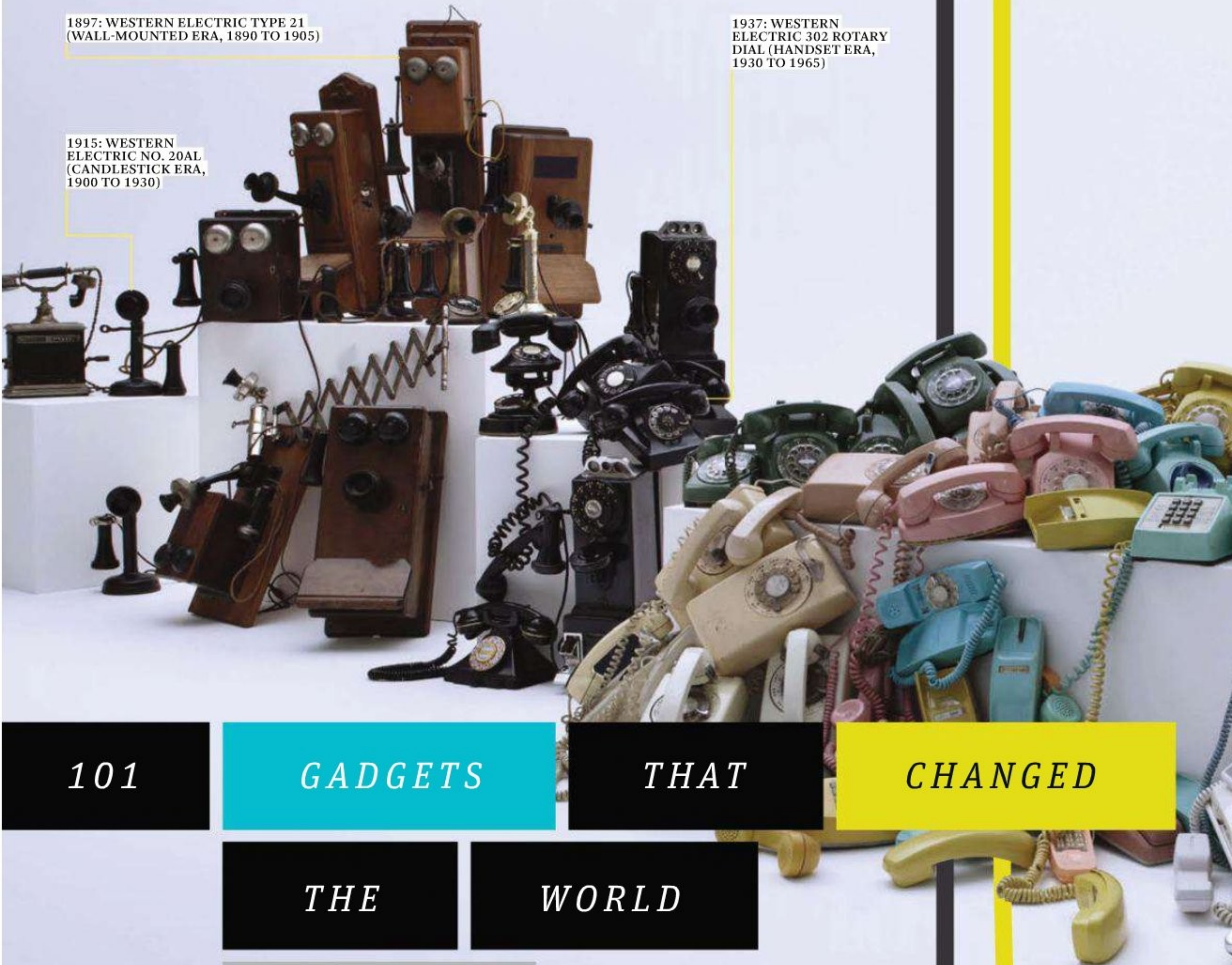


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1897: WESTERN ELECTRIC TYPE 21
(WALL-MOUNTED ERA, 1890 TO 1905)

1915: WESTERN
ELECTRIC NO. 20AL
(CANDLESTICK ERA,
1900 TO 1930)

1937: WESTERN
ELECTRIC 302 ROTARY
DIAL (HANDSET ERA,
1930 TO 1965)



101

GADGETS

THAT

CHANGED

THE

WORLD

BY THE EDITORS

PHOTOGRAPH BY JAMIE CHUNG

STYLING BY MEGAN CAPONETTO

The answering machine edges out the sewing machine. The electric guitar trumps the electric toothbrush. But from alarm clock to zipper, all of the items on our list have cultural significance that belies their physical size. Ground rules: A gadget is something you can hold in your hands. Mechanical or electronic, it is a mass-produced, personal item that evolves from novelty to necessity and ultimately shows its paradigm-shifting power. All were selected and ranked by PM, HISTORY and a panel of esteemed inventors, designers and tech gurus, including a moon-walking astronaut. Let the countdown—and the inevitable debate—begin.



● 1. MOBILE/SMARTPHONE

The judges argued over all but one ranking: The smartphone was an easy top pick. With origins tracing back to Finland and Japan in the '70s, mobile phones have fast become the most widely used gadgets in the world. The first billion units sold in 20 years, the second billion in four and the third billion in two. By the end of 2010, the subscription rate stood at 5 billion, or 75 percent of all people on earth. The tech leapt forward in 1983 with the Motorola DynaTAC 8000X, the first truly portable cellphone. The smartphone, with us since 2000, is now a pocket-size PC. Wireless and GPS- and multimedia-enabled, it facilitates instantaneous personal connections that make phone conversations seem like cave paintings. People of developing nations, even those without an electrical grid, can tap into the world's commerce and culture. After a scant 11 years of development, the device seems to have limitless potential.

1983: MOTOROLA
DYNATAC
(CELLPHONE ERA,
1983 TO PRESENT)

2007: APPLE IPHONE
(SMARTPHONE ERA,
2000 TO PRESENT)

PANEL OF EXPERTS

DRAWING FROM THE FIELDS OF DESIGN, TECHNOLOGY AND INVENTION, POPULAR MECHANICS AND HISTORY ASSEMBLED A PANEL OF EXPERTS WHO HELPED SELECT AND RANK THE 101 MOST SIGNIFICANT GADGETS.

Buzz Aldrin

Apollo 11 astronaut

Greg Allgood

Director, Children's Safe Drinking Water at Procter & Gamble

Paola Antonelli

Curator of architecture and design, Museum of Modern Art, New York

Bianca Bosker

Technology editor, Huffington Post

George Davison

Founder and CEO of Davison International

James Dyson

Inventor, Dyson Dual Cyclone vacuum

Shawn Frayne

Inventor/president, Humdinger Wind Energy

Lauren Goode

Producer/reporter, The Wall Street Journal Digital

Lonnie Johnson

Inventor, Super Soaker

Brian Lam

Editorial director, Gizmodo

Tim Leatherman

Inventor/founder, Leatherman Tool Group

John Maeda

President, Rhode Island School of Design

David Pogue

Technology columnist, The New York Times

Elsbeth Rountree

Digital strategist

Witold Rybczynski

Martin & Margy Meyerson Professor of Urbanism and professor of real estate, The Wharton School, University of Pennsylvania

Tim Wu

Professor of law, Columbia University; author, *The Master Switch*

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● 2. RADIO

Police switchboards jammed. Drivers fled cities. Doctors volunteered to treat the injured. Why all the ruckus? On Oct. 30, 1938—the day before Halloween—Orson Welles presented a radio play he based on H.G. Wells's sci-fi novel *The War of the Worlds*. The *Mercury Theatre on the Air* presentation sounded like a news broadcast of a Martian invasion, complete with fake bulletins that interrupted dance music. The resulting hysteria dramatically revealed the power of gadget No. 2, the first instrument of instant mass communication. Patented in England in 1896 as "wireless telegraphy" by Guglielmo Marconi—who based his work on technology developed by Nikola Tesla—radios were in 80 percent of U.S. homes by the time those aliens landed in New Jersey.

● 3. TELEVISION

"We wouldn't have had a prayer without that gadget," John F. Kennedy said of the tube. Most of the 75 million Americans who watched the debates between Kennedy and Richard Nixon during the 1960 election gave the nod to the senator from Massachusetts.



Conceptualized in 1877 by Edison and Bell and patented by inventor Philo T. Farnsworth in 1930, television spread rapidly after World War II, bringing local and international events into the world's homes. In 2008, a record 4.7 billion people tuned in during the two-week broadcast of the Beijing Olympics.

● 4. HYPODERMIC SYRINGE

The promise of the hollow needle, invented in 1844, was realized a century later as injected vaccines spared millions from polio, tuberculosis, rabies and more.



● PERSONAL COMPUTER

The first one was a player piano for the mathlete crowd. When the Altair 8800 debuted in 1975, it was a hobbyist kit with no defined purpose. Mainstream minds were not exactly blown, but the geeks saw the binary on the wall. Within months, Bill Gates released a programming language for the Altair, and by 1977, the Apple II revealed the personal computer's true potential: It shipped with the video game *Breakout*.

6. PORTABLE AIR CONDITIONER

See p. 56, *Gizmo Expos*

● 7. TELEPHONE

"As a practical man, I did not quite believe it; as a theoretical man, I saw a speaking telephone by which we could have the means of transmitting speech and reproducing it in distant places. *But it really seemed too good to be true...*" — Alexander Graham Bell, *Popular Mechanics*, 1912

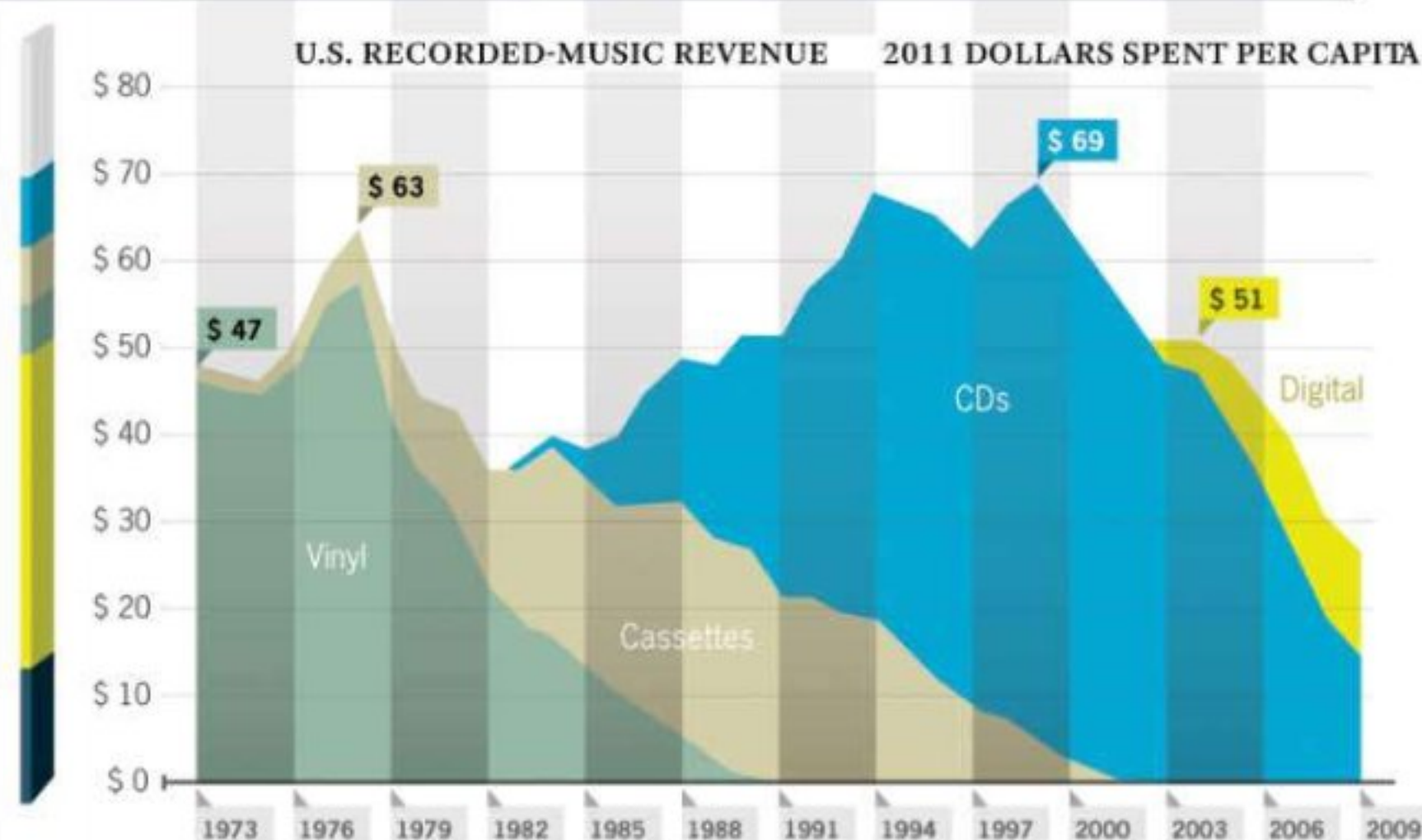


MUSIC MACHINES

THIS GADGETRY TRACKS THE RISE AND FALL OF FORMATS—BOTH RECORDING AND PLAYBACK—AND THE SPREAD OF DIFFERENT MUSICAL GENRES.

● **8. Phonograph** When Thomas Edison unveiled the first device to record and play back sound in 1877, he foresaw—brace yourself—automated messages delivered over phones. Luckily, Edison's embossed tin cans gave way to the wax cylinders and vinyl discs that spawned

Apple sold 600,000 first-gen iPods in two years, despite some warts such as no PC compatibility.



the recording industry.

● **Transistor Radio** "World's first transistor radio" is too modest. By replacing vacuum tubes with transistors, 1954's Regency TR-1 became the first portable media player. (#16)

● **Hi-Fi** The 1950s boom in

high-fidelity gear revealed a new breed of consumer—gadget buffs masquerading as music purists. (#25)

● **Cassette Tape** Mix tapes and bootlegs of the '80s put this format on top, and music labels on notice. (#50)

● **Walkman**

Speaking of mix tapes, in 1979, Sony's portable cassette player was not only small—it also pioneered the use of headphones. (#45)

● **Boombox** Polar opposite



of the Walkman, the boombox took the party to the streets, channeling hi-fi audio tricks into hip-hop rebellion. (#70)

● **CD Player** This first step between analog and digital media overtook cassettes in the 2000s, with 20 billion CDs sold by 2007. (#30)

● **MP3 Player** The MP3 era began in 2003, with the launch of Apple's iTunes store. The iPod's 2001 introduction got the most attention, but iTunes broke the record-company mold, allowing more artistic freedom. The outlet has sold more than 10 billion songs; those sales of singles, combined with digital piracy, explain why the average American's spending on music dropped to a mere \$26 in 2009. (#42)

Data: Recording Industry Association of America; analysis: Michael DeGusta

GADGETS
THAT
WILL CHANGE
THE
FUTURE

PERSONAL
ROBOTS

The first mass-market home robots are not multifunction, Rosie-style servants, but rather purpose-built autonomous machines. So, in the future, we'll be served by intelligent appliances, not the mechanical "people" we'd envisioned.

FACEOFF

14.5 LUMENS PER WATT

INCANDESCENT

10.

65 LUMENS PER WATT

LED

In this corner, from Menlo Park, N.J., the 131-year-old champ, the incandescent bulb

OPPONENTS

From Syracuse, N.Y., the 49-year-old challenger, the LED (#31)

Multiple; Thomas Edison is credited with developing the first commercial incandescent bulb in 1879.

INVENTOR

Multiple; Nick Holonyak Jr. of GE pioneered the first practical visible-spectrum LED in 1962.

\$1.34

AVERAGE COST PER BULB

\$54

1500 hours

AVERAGE LIFE SPAN

60,000 hours

14.5 lumens per watt

EFFICIENCY

65 lumens per watt

Original heavyweight now generates more heat than light, but stubbornly refuses to throw in the towel.

<< SPLIT >>
DECISION

Low-watt upstart with modest early bouts as indicator in electronic gear, but now odds-on favorite as the future of lighting.



Rover Safety Bicycle, circa 1885

11. DRY CELL BATTERY

See p. 66, Flashlight

12. BICYCLE

Chain-driven safety bikes trumped big-wheeled "ordinaries" and gave mobility to bustle-wearing women. "I think [bicycling] has done more to emancipate women than anything else," Susan B. Anthony said in 1896. *"I rejoice every time I see a woman ride by."*

9. ALARM CLOCK

Alarm clocks predate the Seth Thomas brand by centuries, but the clockmaker's 1876 model fit on a nightstand and helped drag the Industrial Revolution out of bed.

13. MATCH

The first nonpoisonous match wasn't invented until 1910. Before that, a book of matches packed enough toxic white phosphorus to kill a person.

14. QWERTY KEYBOARD TYPEWRITER

Early writing machines jammed easily and were "full of caprices, full of defects—devilish ones," Mark Twain wrote. In the 1870s, Christopher L. Sholes studied letter-pair frequency (which letters are used together most often, such as *th*) and reorganized the letter-key layout. The resulting qwerty keyboard, introduced in the Remington Standard 2 typewriter in 1874, prevented type bars from crossing up—and survives to this day as a computer keyboard.

15. MODEM

In 1949, the first modems converted U.S. Air Force radar data into sounds and squawked them over phone lines. A receiver then translated the noises back into data. ("Modem" draws from the first letters of the words describing the process: "modulation" and "demodulation.") Transmission was slow until the late 1990s, when it hit 56 kbps, fast enough to learn that "you've got mail."

GADGETS THAT WILL
CHANGE THE FUTURE

INDUCTIVE
CHARGERS

Now available as accessories from companies such as Powermat and Energizer, plugless chargers will soon be integrated directly into devices, making power as wireless as data currently is. Future systems could run small appliances and even TVs.

16. TRANSISTOR RADIO

See p. 53, *Music Machines*

17. HANDHELD GPS

Before GPS was a road warrior's tool, it was the nav system for actual U.S. military warriors. The government opened up GPS for civilian use in 1983, after the Soviets downed a Korean airliner in a no-fly zone. Magellan sold the first handheld unit in 1989.

18. VACUUM CLEANER

Early home vacuums were very expensive: The 1908 Hoover Model O went for \$60, about \$1437 in 2010 dollars. Prices had dropped sufficiently by the mid-1950s to make upright vacuums a middle-class staple.

19.

19. BROWNIE CAMERA

Inexpensive and easy to operate, the Brownie was one of the first box cameras and brought the snapshot to the masses when it hit stores in 1900. Ansel Adams's parents gave one to their son during a 1916 trip to Yosemite, when the future landscape photographer was 14. While setting up his first photo, Ansel tumbled off a tree stump and inadvertently pressed the shutter. He rated the accidental image "one of my favorites from this, my first year of photography."



Ansel Adams, 16, Yosemite National Park, 1918

TUBE TOYS

WE SUBMIT: THE GADGETS THAT MAKE TELEVISION EASIER AND MORE FUN TO WATCH RIVAL THE INVENTION OF THE TV ITSELF.

FLASH-MATIC TUNING

BY ZENITH

ONLY ZENITH HAS IT!



20. Remote Control

No need to rise from a recumbent position to change channels or adjust the volume. Just point the Zenith Lazy Bones at the small screen and limit exercise to your thumb. This first remote control, invented in 1950, was tethered to the tube by a wire; the first wireless remote, the Flash-matic, used a beam of light to operate the TV.

• **VCR** "Now you don't have to miss *Kojak* because you're watching *Columbo*," Sony's 1976 ad for the first Betamax VCR said. Studio execs, anxious to protect copyrights, rushed into court. The legal battles

dragged on until 1984, when the U.S. Supreme Court finally okayed home taping. (#22)

• DVD Player

The prototype, developed in 1994 by Toshiba, was a pile of circuit boards nicknamed the "fire watch-tower." Though unstable, it proved that DVD quality crushed that of VHS. Players came out in 1996; the first DVD movie release, *Twister*, in 1997. (#77)

• Digital HDTV

In 1987, Japanese engineers

showed off their MUSE hi-def system in Washington, D.C. Policymakers responded by pushing for new broadcast standards, and after much debate and many delays, HDTVs arrived in stores in 1998. Today, they're in more than half of U.S. households.

(#38)



• **Digital Video Recorder** In 2002, network execs worried that DVRs were TV killers. "There's no Santa Claus," one CEO said. "If you don't watch the commercials, someone's going to have to pay for television, and it's going to be you." The CEO was wrong. Today, almost half of DVR users still watch ads, and the networks have seen ratings jump an average of 10 percent, thanks to playback. (#91)



21



• ANSWERING MACHINE

Released in 1971, the Phone-Mate Model 400, the first widely used answering machine, was a blessing and a curse. Its tapes could capture 20 messages, enabling selective communication. The downside: phone tag, screened calls. Pop culture had many takes on the gadget, but a 1997 *Seinfeld* bit stands out: To avoid talking to his girlfriend, George repeatedly listens to his own outgoing message, a parody of the *Greatest American Hero* theme, as calls from other people

pour in. By the fifth time, it's downright tragic—not unlike George himself.

22. VCR

See p. 55, Tube Toys

• 23. LAPTOP

In the age of the MacBook Air, a computer weighing more than a few pounds seems like a desktop. But the most successful early laptop was the 11-pound GRiD Compass 1101, a clamshell computer that went on sale in 1982. The gadget spurred innovation; today, 59 percent of U.S. adults own a desktop and 52 percent own a laptop. In the 18- to 34-year-old demographic, seven in 10 are laptop owners.



24. SEWING MACHINE

See below, Gizmo Expos



25. HI-FI

See p. 53, Music Machines

GIZMO EXPOS

COME ONE, COME ALL TO THE WORLD'S FAIR AND MARVEL AT THE OPTIMISTIC, FUTURISTIC TECH!



• **24. Sewing Machine** Eighty years after the first mechanical stitcher cut the time it took to sew a shirt from 14 hours to 1, Singer unveiled a portable version (the 11-pound

Featherweight) at Chicago's 1933 Century of Progress fair. • **Portable Air Conditioner** At the World's Fair during the hot New York summer of 1939, Willis Haviland Carrier and his

scantily clad female assistants demonstrated the first room air conditioner. In 1953, Americans bought more than 1 million window a/c units; over the past five years, manufacturers shipped (gasp!) 41 million. (#6)

• **Zipper** The button's dominance began to slip in 1921, when B.F. Goodrich used a "separable fastener" (a redesign of a closure that debuted at the 1893 Chicago World's Fair) in its Zipper boots. Soon zippers were everywhere, replacing buttoned-up class with interlocking efficiency. (#65)

GADGETS THAT WILL CHANGE THE FUTURE MOTION-CAPTURE DEVICES

The Microsoft Kinect Xbox peripheral is the first mass-market motion-capture device, and its tech pioneered a new gestural computing interface. In the future, interactions with computers will be conversational—and facial expressions may take the place of a mouse.

PHOTOGRAPHS BY EVERETT COLLECTION (SEINFELD), SWIM INK 2, LLC/CORBIS (POSTER)



MAN AT WORK

THESE GADGETS TURNED HOMES INTO DIY CASTLES.

• **26. Crescent Wrench** On his 1927 trans-Atlantic flight, Charles Lindbergh said he carried only "gasoline, sandwiches, a bottle of water, a Crescent wrench and pliers." The Crescent Tool Company's invention, designed for car brake and clutch adjustments, is still a go-to home-repair tool.

• **Electric Drill** The workshop's most common power tool was

introduced by Black & Decker in 1916, with a grip loosely based on the handle of the Colt .45. (#39)

• **Circular Saw** The quest to downsize and repurpose the spinning blades used in sawmills led to the 1923 invention of the worm-drive circular saw by one Edmond Michel. The Michel Electric Handsaw Company was later renamed Skilsaw Inc., hence the early

nickname for all circ saws. (#49)

• **Push Lawn-mower** The essential yard gadget was inspired by a factory tool: the carpet cutter. (#51)



• **Tape Measure** After World War II, carpenters used the gadget more than ever, speeding up construction and contributing to a major building boom: 14.1 million homes in a decade. (#66)

• **Chain Saw** Enormous "tree-cutting machines" date back to the 1920s, but 30 years later, backyard warriors were using solo saws to prune trees and cut firewood. (#76)

Power to the people: This early Black & Decker electric drill revolutionized the handyman's arsenal.

• **Leaf Blower** The gas-powered models are noisy and air-polluting. But that hasn't stopped their proliferation in suburbs nationwide, exponentially reducing yard-maintenance time. There's even a game called leaf-blower hockey. Try *that* with a rake. (#81)

• 27. BLACKBERRY

"It will soon be possible to transmit wireless messages so simply that an individual can carry his own apparatus," inventor Nikola Tesla said in 1909. The BlackBerry arrived in 1999.

• 28. ELECTRIC GUITAR

Leo Fender designed the first mass-produced solid-body electric guitar, the Telecaster, in 1951—when Keith Richards was 8.

• 29. CAMCORDER

America's Funniest Home Videos showed the success of JVC's 1984 creation; at the height of the show's success, producers received 2000 tapes a day.

• 30. CD PLAYER

See p. 53, Music Machines



31. LED

See p. 54, Faceoff

• 32. MOUSE

In 1952, Canadian researchers used a bowling ball to create the first trackball. Thirty-one years later, Apple paired its Lisa computer with a small controller that has retained the same basic design for decades.



33. MICROWAVE

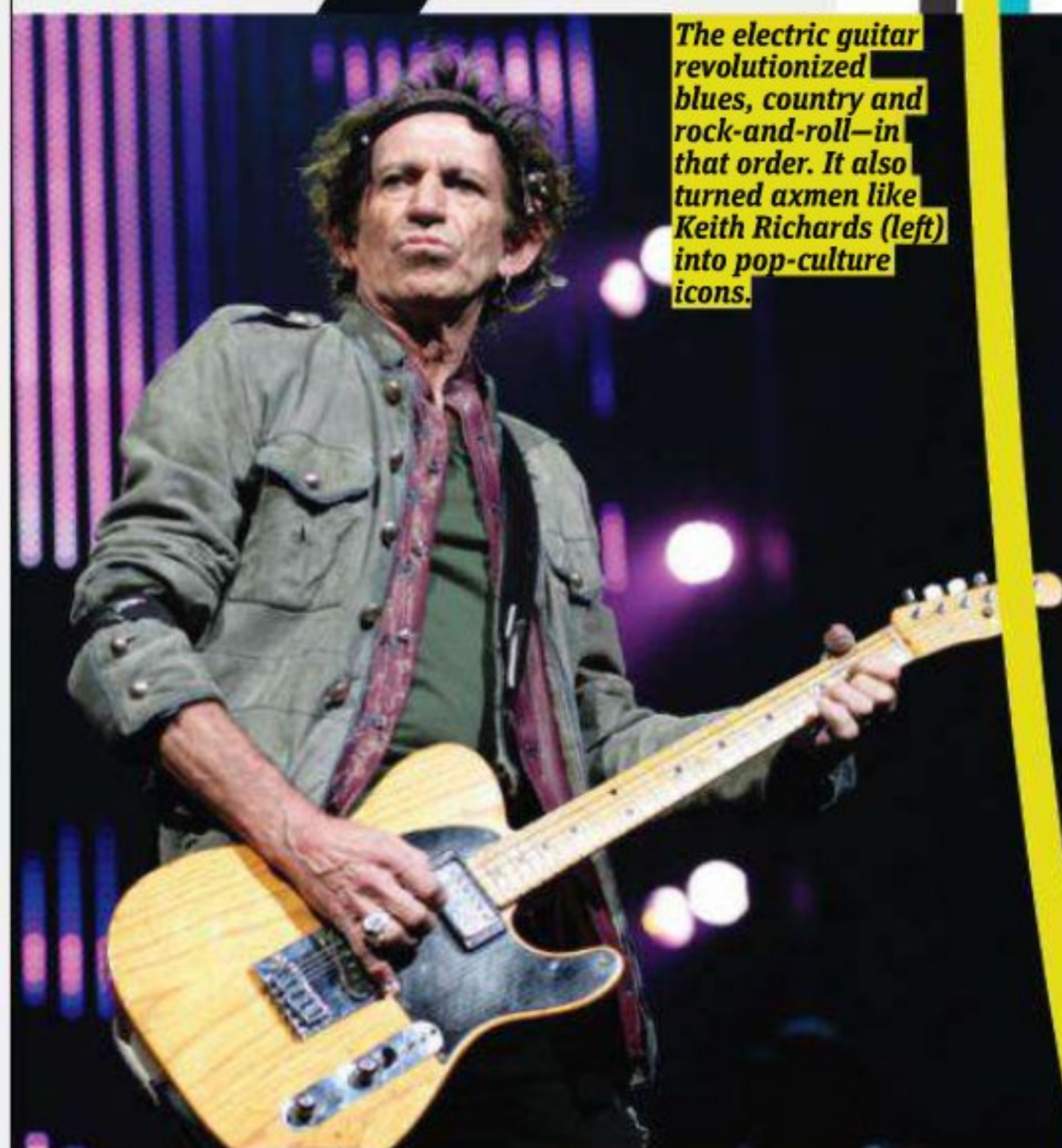
See p. 65, Cook-O-Matic

• 34. DIGITAL CAMERA

Because of the popularity of this gadget, introduced in 1990, Kodak retired its Kodachrome film format in 2009, after 74 years of service.

• 35. MICROPHONE

A single word explains its role in bridging East and West: karaoke.



The electric guitar revolutionized blues, country and rock-and-roll—in that order. It also turned axmen like Keith Richards (left) into pop-culture icons.



Dallas clothing manufacturer Abraham Zapruder was filming JFK's motorcade in Dallas on Nov. 22, 1963, with this Bell & Howell camera when the president was assassinated. The camera is now in the National Archives in Washington, D.C.

36.

• 8-MM CAMERA

It's the most famous home movie in history: 486 frames that record on Kodachrome II safety film the assassination of President John F. Kennedy. Abraham Zapruder had left his Bell & Howell 414PD Zoomatic camera at home that day, but at his assistant's urging, he drove 14 miles

round-trip to retrieve it. Each winding of the mechanical camera's mainspring lasts 30 seconds; the footage that became critical evidence in the Warren Commission's report on the assassination is 26 seconds long.

• 37. WRISTWATCH

In 1901, while celebrating in Paris after winning a prize for circling the Eiffel Tower in a dirigible, Brazilian aviator Alberto Santos-Dumont asked his friend Louis Cartier to design a watch that would permit him to time aerial maneuvers and still keep his hands on the controls. Three years later, the Santos men's wristwatch, with a leather strap and buckle, went on sale. Santos-Dumont was wearing it on Oct. 23, 1906, when he made the first successful airplane flight in Europe—and the first one anywhere in a craft with nondetachable landing gear.



38. HDTV

See p. 55, Tube Toys



39. ELECTRIC DRILL

See p. 57, Man at Work

• 40. WI-FI ROUTER

Wi-Fi has made its way into more than 9000 devices, from phones to TVs, since its introduction in 2000. According to a Wi-Fi Alliance poll, 75 percent of young Americans say they'd give up coffee before Wi-Fi.

• 41. CALCULATOR

Math nerds couldn't slip the first all-transistor calculator (1957) into their shirt pockets: The three-unit IBM 608 weighed 2400 pounds. Anyway, at \$83,210, it was too pricey. By 1976, four-function pocket calculators weighed a few ounces and cost a few dollars.

GADGETS THAT WILL
CHANGE THE FUTURE

MOBILE HOTSPOTS

Receivers such as the Novatel MiFi hotspot, which takes long-range 3G and 4G cellular signals and turns them into short-range Wi-Fi networks, may, in the future, allow high-speed Internet access to reach areas where broadband infrastructure cannot.

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    **GET CONNECTED**

42.

**MP3 PLAYER**See p. 53, *Music Machines*• **43. POLAROID CAMERA**

In 1943, Jennifer Land, 3, watched her father, Edwin, take photos: "Why can't I see the pictures *now*?" Her plea was answered in 1948, when Polaroid—the company her father headed—began selling instant film and cameras. It spent 10 years and \$250 million developing the iconic SX-70, which debuted in 1972. The expenditure nearly sank the firm, but by 1974 the camera was a hit: It spit out 1 billion prints that year.

**45. SONY WALKMAN**See p. 53, *Music Machines*• **46. FIRE EXTINGUISHER**

The first model (1723) sounds more dangerous than the fire: a cask that held liquid and a pewter gunpowder chamber connected to fuses. At the first flicker of flame, the occupant lit the fuses to ignite the gunpowder, which scattered the retardant. Today, U.S. homeowners douse 13 million fires with extinguishers that spray foam, soda acid or carbon tetrachloride.

SAVING THE WORLD



WHEN IT COMES TO DIGITAL STORAGE, SIZE CUTS BOTH WAYS—EVER SMALLER DEVICES WITH EVER GREATER CAPACITY. HERE, 40 YEARS OF GROWTH (AND SHRINKAGE).

• **44. Floppy Disk**

In days of yore, when microcomputer hard drives were still a gleam in Seagate's eyes, early adopters loaded operating systems and programs via floppy disks, which IBM introduced in 1971. Floppies kept evolving—from 8 pliable inches to 3.5 rigid ones—

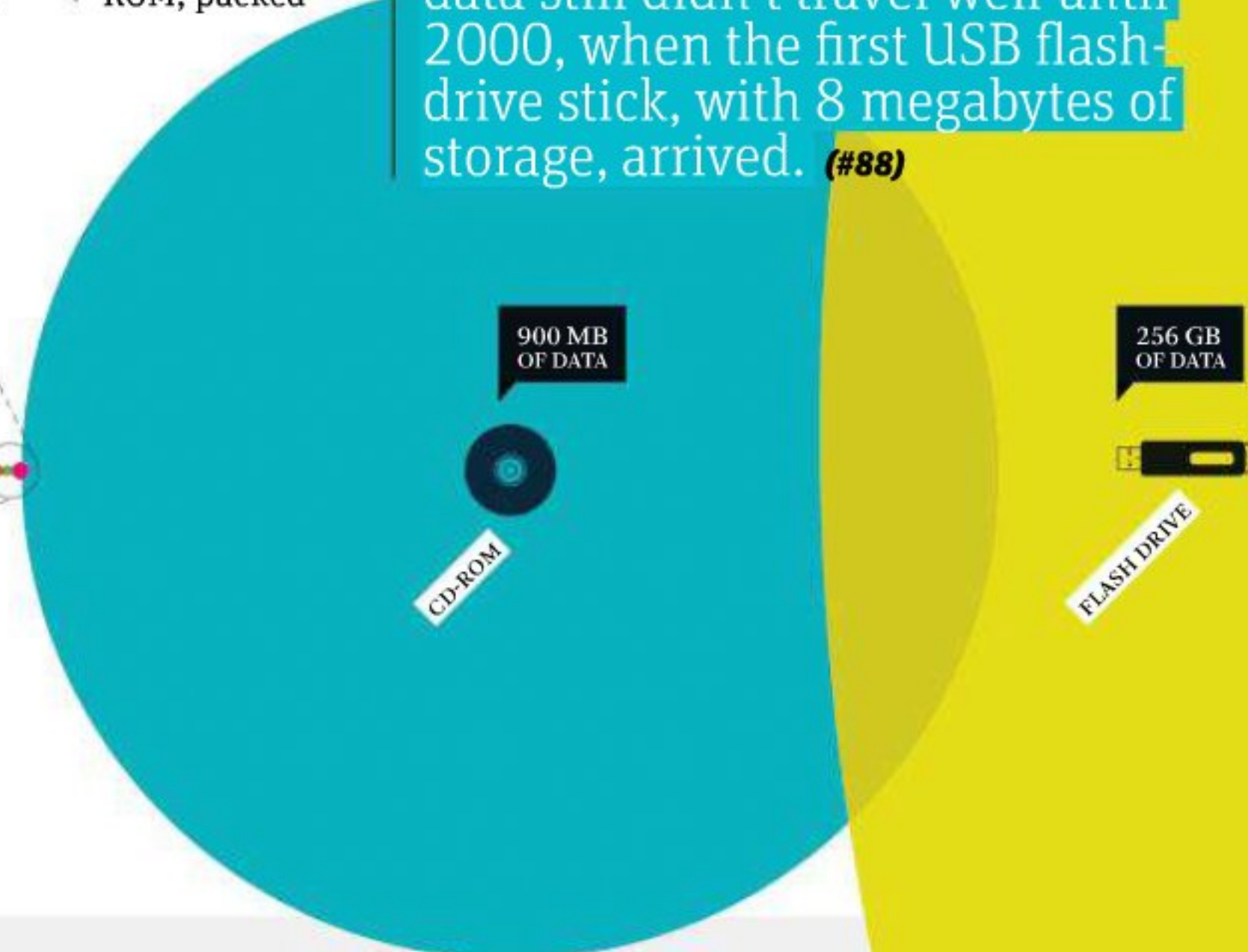
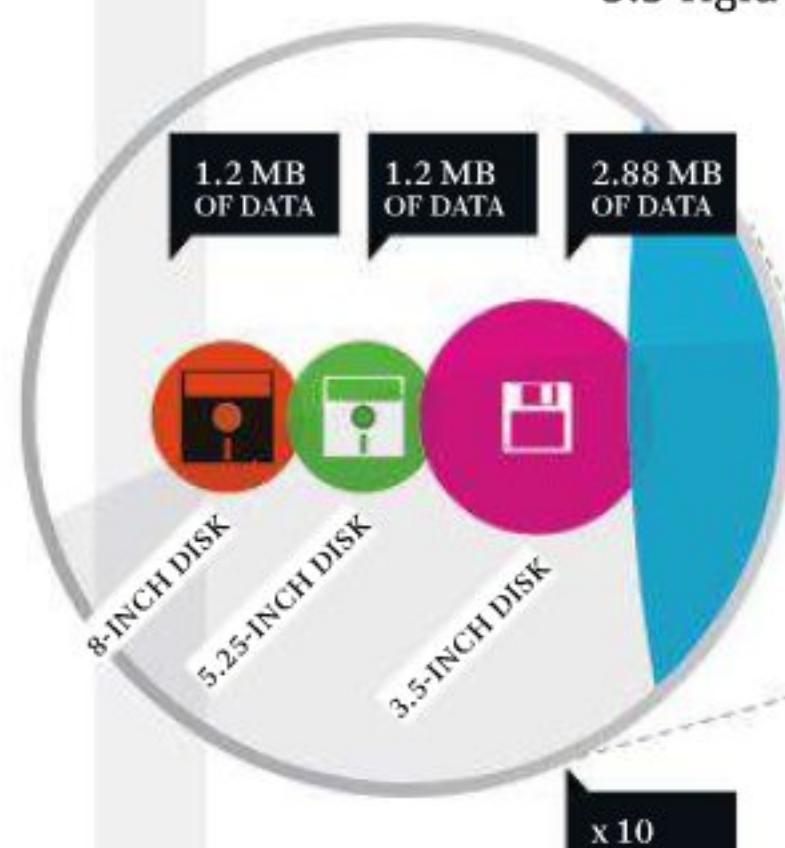
but the rise of CD-ROMs assured their extinction. Gone but not forgotten, the floppy lives on in the Save icon on drop-down menus.

• **CD-ROM**

Early computer games required multiple floppies; *Alone in the Dark*, for example, took four. The CD-ROM, packed

with huge stores of animation and gaming data, allowed kids to upload one disc and disappear into the *Myst*. (#59)

• **Flash Drive** In the early '80s, Toshiba engineer Fujio Masuoka developed flash memory, so named because the erasure process reminded a colleague of a camera flash. But the good ship flash drive needed a way to dock. Intel's Universal Serial Bus (USB) provided part of the solution in 1996. But data still didn't travel well until 2000, when the first USB flash-drive stick, with 8 megabytes of storage, arrived. (#88)






ask me

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FACEOFF

47.

CAN AMERICAN INGENUITY
TRIUMPH OVER...

... THE CLASSIC
SWISS MULTITOOL?



LEATHERMAN (#47)

SWISS ARMY KNIFE (#79)

Tim Leatherman, engineer	THE INVENTOR	Karl Elsener, cutler
Frustration. (A European vacation and the inadequacy of a mere pocketknife to turn a stripped radiator handle.)	THE MOTIVATION	Nationalism. (Elsener was upset that Swiss soldiers carried German-made knives.)
The Pocket Survival Tool, introduced in 1983, had 14 tools, including pliers, four screwdrivers, a can opener, an awl and a blade.	THE START	The Soldatenmesser, introduced in 1891, had four tools: a blade, an awl, a can opener and a screwdriver.
The Surge has 21 tools and two drill bits.	THE STATS	The SwissChamp xlt has 35 tools, including a wood chisel.
A hard-charging contender vying for the top spot.	THE WINNER >>	A timeless tool that has the edge for now.

● **48. GAME BOY**

Among the most successful gaming systems ever—118 million units and half a billion games sold—the Game Boy has been making road trips peaceful for parents since 1989.



● **49. CIRCULAR SAW**

See p. 57, *Man at Work*



● **50. CASSETTE TAPE**

See p. 53, *Music Machines*



● **51. LAWNMOWER**

See p. 57, *Man at Work*

● **52. KINDLE E-READER**

"I'm not a gadget person at all, but I have fallen in love with this thing."
—Oprah Winfrey, shortly after the Kindle's 2007 launch

● **53. CAR JACK**

Richard Dudgeon devised his first hydraulic jack in 1850 not for automobiles, but for shipyards and railroad repair shops.

● **54. BALLPOINT PEN**

Back in 1945, you could pick up a Reynolds Rocket, America's first ballpoint pen, for a mere \$12.50—the equivalent of about \$150, or 546 Bic pens, today.

● **55. CB RADIO**

Citizens band radio exploded during the 1973 oil crisis, as big-rig drivers scouted speed traps after the national 55-mph limit was imposed. In pop culture, the CB inspired 1975's chart-topping "Convoy" and starred in 1977's *Smokey and the Bandit*.

● **56. TAPE RECORDER**

Between 1971 and 1973, Richard Nixon used several Sony TC-800B machines to secretly record 3700 hours of phone calls and meetings. Most controversial: 18.5 minutes of tape allegedly erased as part of the Watergate coverup.

● **57. HAIR DRYER**

Today, 96 percent of hotel rooms have hair dryers, which were developed in the '20s by engineers who built blender motors.

PHOTOGRAPHS BY STUDIO D (LEATHERMAN), COURTESY VICTORINOX SWISS ARMY (SWISS ARMY KNIFE)

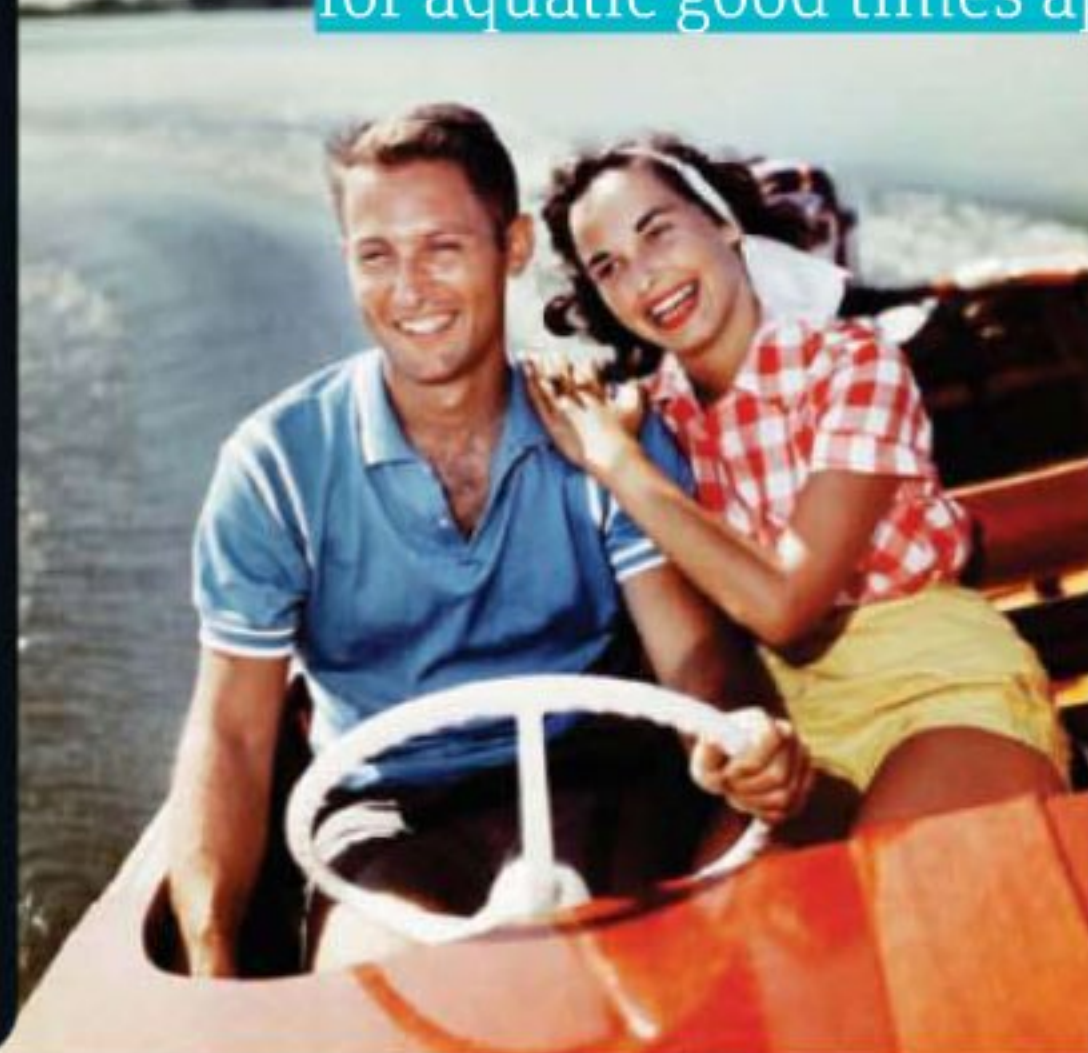


GREAT AMERICAN WEEKEND

A NATION EXHAUSTED BY WORLD WAR II YEARNED TO KICK BACK, LIGHTEN UP AND ENJOY FAMILY TIME. HERE'S THE GEAR THAT MADE IT ALL POSSIBLE.



• **58. Outboard Motor** Ole Evinrude's outboard motor was patented in 1911, but it wasn't until the '50s that powerboating became the choice weekend recreation of the masses: In 1956, 600,000 new outboards hit the water, and the country's thirst for aquatic good times appeared to be unquenchable.



• **Charcoal Grill** There's a reason it looks like a buoy. Chicago metal-shop owner George Stephen borrowed the same shape—and material—used in a harbor guide when he built the first



Weber Kettle, in 1951. Slow to gain favor on the coasts, the grill was a hit in the Brat Belt, where backyard chefs driving the barbecue boom embraced its cooking prowess. (#62)

• **Binoculars** After the war, amateur ornithologists flocked to fields and forests armed with affordable binoculars.

Their hobby was made possible by the Universal Film Company, which, after Pearl Harbor, reconfigured its film manufacturing lines to mass-produce binoculars for use in fields where birders dared not tread. (#67)

• **Coleman Lantern** When W.C. Coleman debuted his Quick-Lite lantern in 1916, he marketed the device to farmers looking to stretch the workday. As electrification spread to rural areas, he rebranded the device as an outdoorsman's essential, and when the popularity of camping skyrocketed after WWII, Coleman lanterns lit up the woods. (#68)

• Spincast Fishing Reel

In 1949, the Zero Hour Bomb Company faced extinction, with its patent on an oil-field time bomb running out. Then, R.D. Hull presented the company with plans for an easy-to-use enclosed-spool fishing reel. Zero Hour rebranded itself as Zebco and sold thousands of the reels by 1956. (#80)

• **Picnic Cooler** That tub you use to chill beer was patented in 1951 as a "Portable Ice Chest for Storing Foods and the Like." Thank goodness it later



got a new name, when, um, cooler heads prevailed. (#92)

• Quick-Release Ski Bindings

After a wicked 1937 accident on the slopes, made worse by fixed bindings, ski champion Hjalmar Hvam had a vision: "When I came out of the ether, I called the nurse for a pencil and paper. I awakened with the complete principle of a release toe iron." (#96)

• Fiberglass Fishing Rod

When hostilities in Asia curtailed bamboo imports, rod-makers needed a new material to keep anglers equipped with low-cost, quality tackle in the '50s and '60s. Fiberglass fit the bill. (#100)

47-58

GADGETS 101

GADGETS THAT WILL CHANGE THE FUTURE OLED LIGHTING PANELS

These low-voltage panels can be built directly into structural materials and printed onto flexible substrates, meaning that, among other things, your wallpaper and lighting will soon be one and the same.

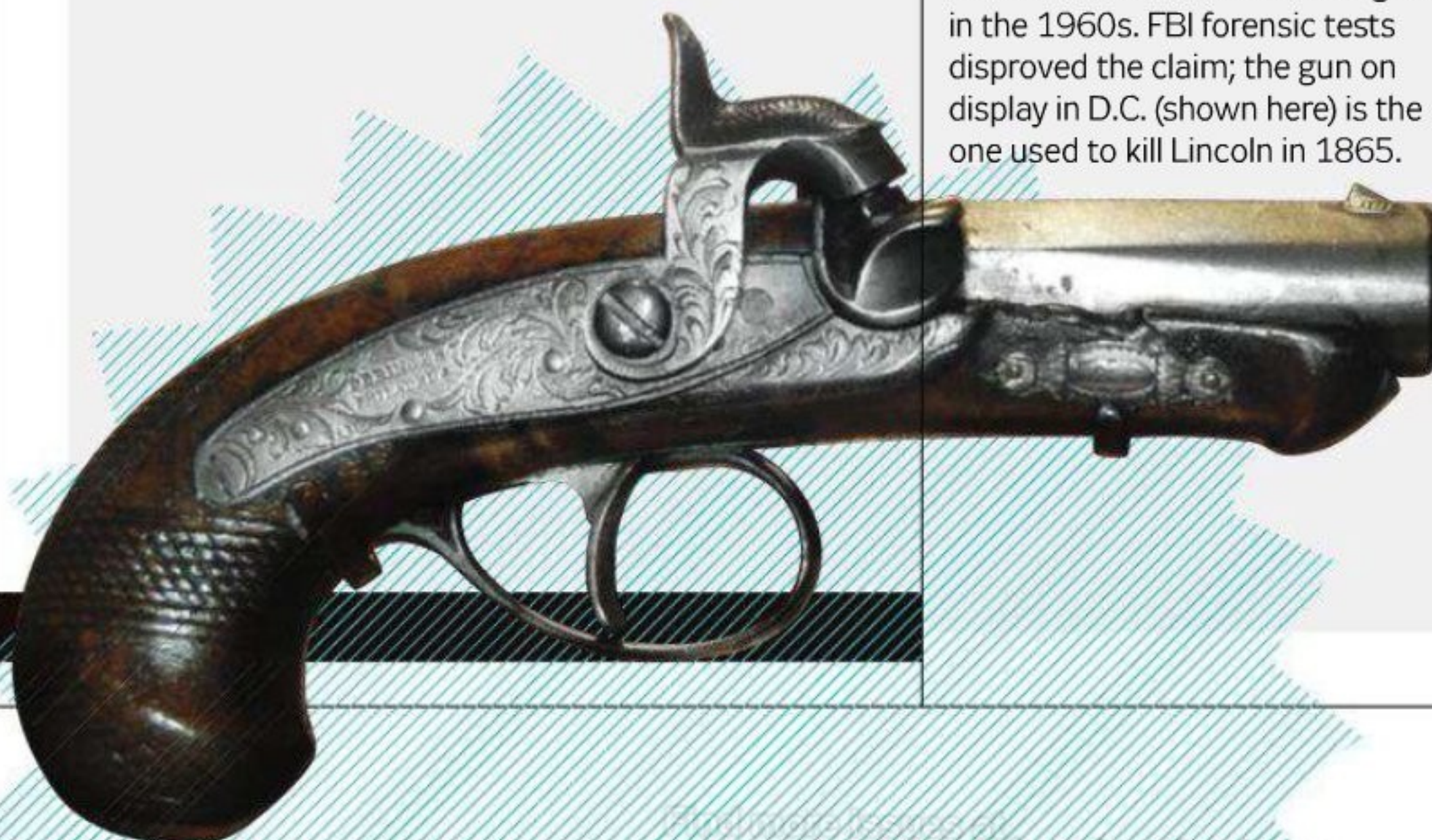


Pre-PowerPoint-era bosses relied on the Kodak Carousel (#71) for visual communication. Here, Don Draper pitches the ad campaign for the gadget on *Mad Men*.



64.

The derringer used to assassinate Abraham Lincoln was actually a deringer, with one r. Renowned pistol-maker Henry Deringer's original Philadelphia Deringer, produced from 1852 through 1868, spawned copycats worldwide, and the name—albeit misspelled—became a generic term for any small, large-caliber handgun.



59. CD-ROM
See p. 60, *Saving the World*

60. MOOG SYNTHESIZER

Among the first widely used electronic instruments, the Moog used analog circuits to generate sound electronically. Without it, the Doors' *Strange Days*, Simon & Garfunkel's *Bookends* and the Beatles' *Abbey Road* would have sounded much different.

61. SMOKE DETECTOR

Duane Pearsall wanted to curb static in photo darkrooms, but noticed that a meter measuring ion concentration on his static-control device flat-lined whenever cigarette smoke hit it. "By accident, we had discovered how to make an ionization smoke detector," Pearsall said.

62. CHARCOAL GRILL

See p. 63, *Great American Weekend*

63. LUNCHBOX

When Aladdin Industries launched the Hopalong Cassidy kit in 1950, it kicked off the lunchbox boom: *Between 1950 and 1970, 120 million lunchboxes shot off store shelves* as America's youth scrambled to get the latest in branded boxes.

DERRINGER

The authenticity of the Booth deringer at Ford's Theater came into question in 1997 after members of a bygone burglary ring claimed to have stolen the original in the 1960s. FBI forensic tests disproved the claim; the gun on display in D.C. (shown here) is the one used to kill Lincoln in 1865.

65. ZIPPER
See p. 56, *Gizmo Expos*

66. TAPE MEASURE
See p. 57, *Man at Work*

67. BINOCULARS
See p. 63, *Great American Weekend*

68. COLEMAN LANTERN
See p. 63, *Great American Weekend*

69. ELECTRIC TOOTHBRUSH
U.S. Navy submariners didn't have much to smile about: Subsisting on mushy canned food for months on end, they got almost zero gum stimulation. Electric toothbrushes came aboard in 1959, solving the problem. They later found a wider audience—and inspired the invention of another vibrating device (but that's a gadget for an entirely different article).

70. BOOMBOX
See p. 53, *Music Machines*

71. KODAK CAROUSEL
Adman Don Draper said it best in his pitch to Kodak execs in an episode of the '60s-set show *Mad Men*: "This device isn't a spaceship, it's a time machine." He waxed poetic about the Carousel, the ingenious 35-mm slide projector, while clicking through images of his family life before it unraveled. "It lets us travel the way a child travels—around and around and back home again."

72. STOPWATCH
When the TAG Heuer Mikrograph stopwatch was invented in 1916, it allowed the measurement of time with unprecedented accuracy—down to $\frac{1}{100}$ second. This precision led to major changes in the sports world, including records such as the world's first sub-4-minute mile (3:59.4, by Roger Bannister, May 6, 1954). Digital stopwatches accurate to $\frac{1}{1000}$ second debuted in 1971.



73. PRINTER

Hewlett-Packard's LaserJet cost \$3500 when it came out in 1984. Today, lasers are cheap, but their ammo isn't—a toner cartridge for a \$100 laser jet costs \$68.

74. SAFETY RAZOR

Stay with us now: "Every razor sold represents a saving of half an hour spent in a barbershop... With an approximate number of 10 million customers, this would represent a saving of 5 million hours... [or] 500,000 working days of the labor of 500,000 men. [At] \$3 per day [this] represents a saving of \$1.5 million per day, or for a year of 300 days,

\$450 million." — *King Camp Gillette, inventor, Gillette Safety Razor, 1918*

75. ELECTRIC BLANKET

Breakfast-cereal inventor and Battle Creek Sanitarium director John Kellogg advocated sleeping outdoors to promote general wellness. His "thermo-electric" blanket enabled residents to enjoy fresh air regardless of the season.



76. CHAIN SAW

See p. 57, *Man at Work*



77. DVD PLAYER

See p. 55, *Tube Toys*



COOK-O-MATIC

1950S KITCHENS WERE TESTBEDS FOR INNOVATION.

- **78. Can Opener** The nuclear family wanted something as over-engineered as postwar America, so GE rolled out the automatic electric can opener in 1958.
- **Toaster** The pop-up toaster came of age in the '50s, using heat sensors, not timers, to deliver perfectly



browned bread. (#83)

- **Blender** In a 1949 TV commercial, blenders became more than drink mixers: The Vita-Mix created a meal from peanuts, carrots, apples and eggs—shells included. (#94)
- **Teflon Pan** DuPont says the coating it debuted in 1961

has "the world's most slippery substance"; 50 years' worth of eggs agree. (#89)

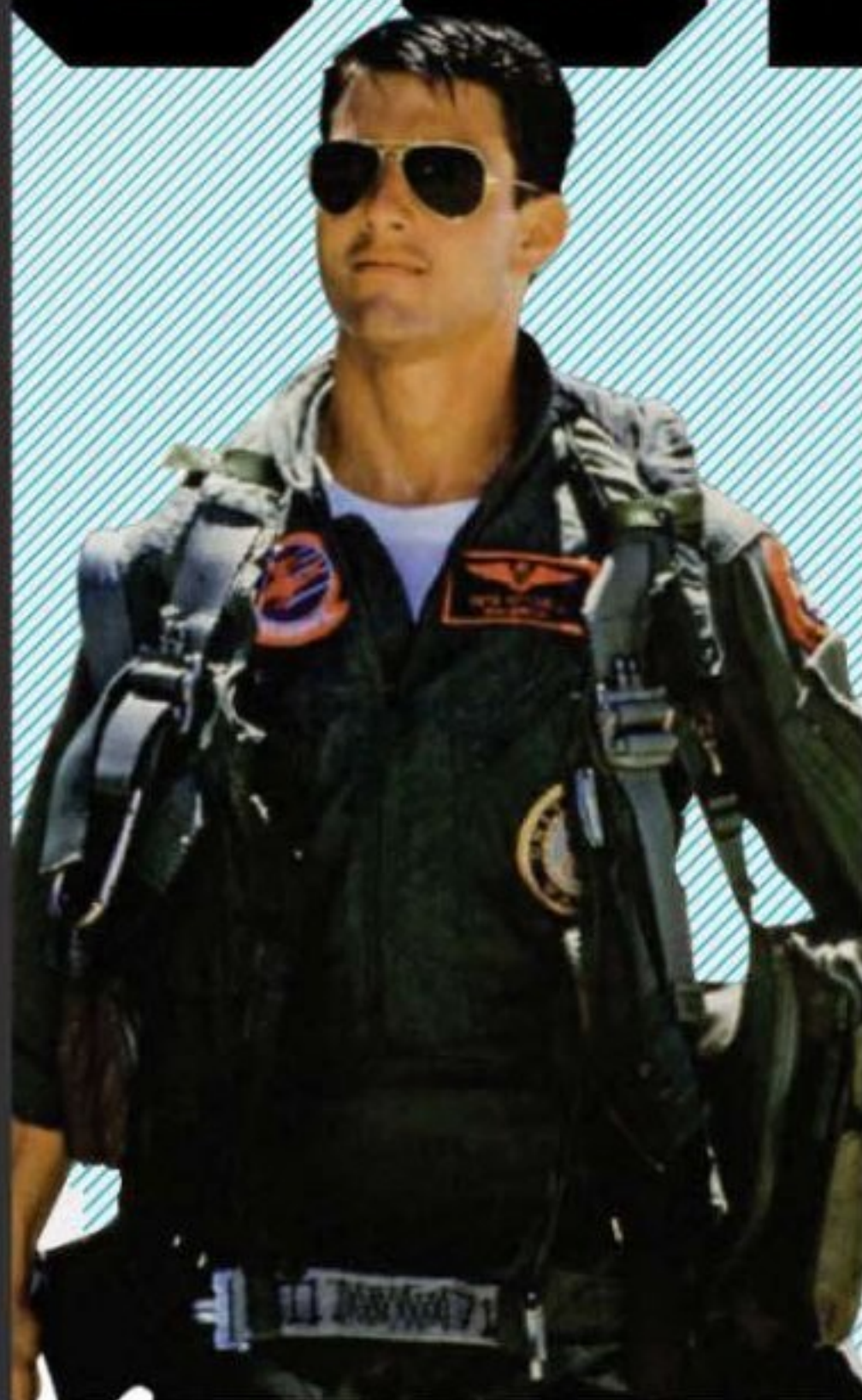
- **Microwave** The first countertop microwave hit stores in 1967—and stayed there. But radiation fears couldn't beat the reheat; by 1975, microwaves outsold gas ranges. (#33)

- **Drip Coffeemaker** Mr. Coffee brought filter brewing to the home in 1972, rendering the percolator obsolete—and the French press more pretentious than ever. (#84)

GADGETS THAT WILL CHANGE THE FUTURE WIRELESS HEALTH MONITORS

Healthcare communications products such as the Bosch Health Buddy have the potential to help tame out-of-control healthcare costs by reducing expensive doctor's-office visits and enabling remote diagnostics.

85.



GADGETS THAT WILL
CHANGE THE FUTURE
TABLETS

79. SWISS ARMY KNIFE

See p. 62, Faceoff



80. SPINCAST FISHING REEL

See p. 63, Great American Weekend



81. LEAF BLOWER

See p. 57, Man at Work

82. FLASHLIGHT

The invention of the dry cell battery (#11) in 1886 paved the way for the flashlight, released in 1898. Early versions earned the moniker for their inability to provide a steady beam.



83. TOASTER

See p. 65, Cook-O-Matic



84. DRIP COFFEEMAKER

See p. 65, Cook-O-Matic

85. SUNGLASSES

Regardless of which Ray-Ban Aviator icon you pick—Gen. Douglas MacArthur during World War II or Tom Cruise in *Top Gun*—it all started in 1929, on the boardwalk in Atlantic City, N.J., where Sam Foster hawked America's first mass-produced plastic sunglasses to beachgoers.

86. HEARING AID

According to the National Institutes of Health, only one out of five people who could benefit from a hearing aid actually wears one.



87. GINSU KNIFE

For better or worse, the late-'70s ads for these blades ushered in the era of the infomercial tout: "But wait—there's more!"



88. FLASH DRIVE

See p. 60, Saving the World

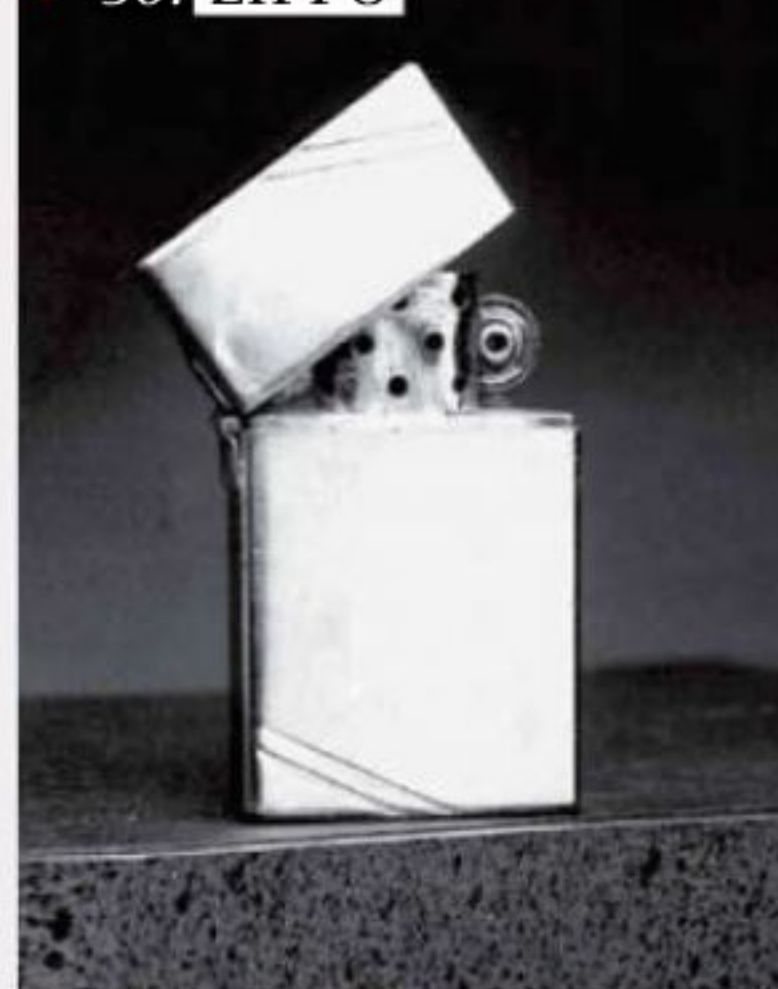


89. TEFLON PAN

See p. 65, Cook-O-Matic



90. ZIPPO



The Zippo moment—when a concert audience raises its lighters in the air—has been rocking the power ballad since the '60s. In 2008, the company introduced an iPhone app for that: The digital Zippo operates just like the real thing, opening with a flick of the wrist, lighting with a swipe of the flint wheel and mimicking real flame movement as the user waves his phone in the air.



91. DVR

See p. 55, Tube Toys



92. PICNIC COOLER

See p. 63, Great American Weekend

93. BRA

"I can't say the brassiere will ever take as great a place in history as the steamboat, but I did invent it."

— Caresse Crosby, who in 1914 used handkerchiefs, ribbon and cord to create an early version of the bra.



94. BLENDER

See p. 65, Cook-O-Matic

Apple's iPad is already a commercial success, but we are only beginning to see the effects of its influence. Tablets represent a new lean-back computing platform that is changing the design of everything from games to fine literature—yes, PopMech has a tablet edition!

"...it's awesome...the best sounding TV ever made!" - **Complex.com**

"...the most dramatic home theater product introduced since the Blu-ray Disc player." - **DigitalTrends.com**

"...eliminates complexity, confusion and the clutter...impeccably conceived system." - Rich Warren, **News-Gazette**

"...the Click Pad Remote...which can control up to five high definition entertainment devices, makes this a powerful system that's simply controlled with a single remote." - Murray Hill, **Postmedia News Service**

"...Bose's new click pad...is the most user-friendly universal remote we've ever tried." - **The Wall Street Journal**

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The new Bose click pad remote.

95.

● SUPER SOAKER

Since 1990, no fewer than two dozen Super Soaker models have wrought backyard mayhem, but none is more coveted than the CPS 2000 Mk1. The most powerful water gun ever manufactured, it shoots nearly a liter of water *per second* up to 50 feet. The Mk1 was discontinued soon after its release, but it's available on eBay for a cool \$350.



96. QUICK-RELEASE SKI BINDINGS

See p. 63, *Great American Weekend*

● 97. AEROSOL SPRAY CAN

In 1941, the USDA's Lyle Goodhue and William Sullivan used the newly discovered refrigerant Freon to enable the deployment of a lethal (to critters, anyway) mist by American troops fighting on insect-infested fronts. The "bug bomb" cocktail, held in a 16-ounce steel canister, consisted of Freon-12, sesame oil and pyrethrum (the last is a natural insecticide derived from chrysanthemum blooms).

● 98. ROOMBA

Before it unveiled the Roomba Floorvac for the home market in 2002, *iRobot* built land-mine-clearing robots, which used the so-called crop circle algorithm. The same tech was adapted to enable the Roomba to circle and sweep autonomously. The device is far and away the best-selling mobile robot.

● 99. STAPLER

No office supply has enjoyed a star turn quite like that of the stapler, which had its breakthrough role in the comedy *Office Space*. Much of the movie's plot revolved around Milton Waddams's beloved red Swingline, but it wasn't until 2002, three years after the film's release—and in response to demand from fans—that Swingline went to market with a red stapler.



100. FIBERGLASS FISHING ROD

See p. 63, *Great American Weekend*

Astronaut Gene Cernan used laminated maps and duct tape to fashion a DIY fender on the Lunar Roving Vehicle during the Apollo 17 mission in the Taurus-Littrow Valley.

● DUCT TAPE

NASA astronauts have used it to make repairs on the moon and in space. The MythBusters built a boat with the stuff. Brookhaven National Laboratory fixed its particle accelerator with it. And enthusiasts have used it to make prom dresses and wallets. You might say it's a material, not a gadget, but trust us: Duct tape is the ultimate multitool. **PM**

REPORTING BY DAVIN COBURN, GLENN DERENE, JOE P. HASLER, ERIN MCCARTHY AND ERIK SOFGE PHOTO RESEARCH BY KERRY L. DURKIN

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A pyrotechnic crew loads shells into mortars at Montreal's La Ronde amusement park, the site of an international fireworks competition.

EVERY YEAR, THE WORLD'S TOP FIREWORKS COMPANIES TRY TO OUTBLAST ONE ANOTHER IN MONTREAL. THE U.S. TEAM AIMED TO WIN WITH ARTISTRY, PRECISION AND HANDMADE SHELLS.

BY CHRISTOPHER MAAG
PHOTOGRAPHS BY LEON CHEW



KABOOM!

T

TWO BOMBS LIFT INTO THE SKY. They rise for precisely 6.5 seconds, streaming fire like comet tails. The explosions hit simultaneously, releasing bolts of white and then showers the hue of burning embers.

More fireworks blink on—a series of orange and white flares strung together to outline a ship. Céline Dion's voice steals over the crowd: "Every night in my dreams, I see you, I feel you." As people realize the ship is the *Titanic*, they begin to scream. The song builds. Fireworks fill the sky, the bombs and notes bursting at precisely the same time.

"Ah! Ça, c'est beau!" yells Ronny Boghen, one of 300,000 spectators watching a Canadian tribute at the 2010 L'International des Feux Loto-Québec, an international fireworks competition in Montreal. "They always do something that surprises!"

Meanwhile, 1700 miles away in Carrier, Okla., Gary Caimano presses start on the photocopier in his office. The machine thumps out another copy of his plan for the competition. Caimano runs a metal ruler over the pages, checking every cue.

He hasn't slept a full night in months; years of stress and cigarettes have stained his cheeks and eyelids purple. In a few hours, Caimano will leave for Montreal, where his tiny company will represent the United States against bigger outfits from seven other nations; most, like those from Italy and France, have competed there multiple times.

The U.S. has claimed eight gold medals since the competition began in 1985, twice as many as any other nation. But this year, the Americans are underdogs. Not that Caimano is intimidated. "Oh, we're gonna bring the rain," he says, laughing. "We're gonna make the sky move."

EVERY SUMMER, the top fireworks companies in the world meet at La Ronde, an amusement park on an island in the St. Lawrence River, where they have \$70,000 and five days to load thousands of aerial explosives for sophisticated pyrotechnic shows synchronized to music. If a regular Fourth of July



Top: Western Enterprises designer and choreographer Gary Caimano (center) with the competition's technical director, Paul Csukassy (left), and PyroMaster consultant Jamie Deye. **Bottom:** the PyroSeeking Firing System in the control room at La Ronde.

display is like a squirt-gun fight, a performance here is like a battle of water cannons. "Everybody's trying to push the best fireworks and the newest launch technology to the absolute limit," Caimano says.

La Ronde's stage invites such brinksmanship. The audience sits on a grandstand beside a man-made lake. Before them lie five firing positions called ramps. (Most big shows have one or two.) Three football fields away, hundreds of 8-inch bombs can launch simultaneously from five concrete bunkers at Ramp 1. Few fireworks sites are this big—or this intimate. Shells also shoot from floating pontoons only 270 feet from the stands. "We can do things here that no one has ever seen before," says Denis Lono, who coordinated the 2010 jury.

Crowds in Montreal prefer shows that start with a wallop nearly as big as the finale. From there, most designers splice together snippets from dozens of songs, packing the soundtrack full of

THE SCIENCE OF FIREWORKS

Each explosion in a fireworks display begins with a shell. Inside, "stars" filled with chemical compounds surround a core of black powder. After a shell launches, a fuse sparks the powder, firing stars in all directions. The stars ignite, setting off chemical reactions that create various effects. "Everything you see in a fireworks show is chemistry in action," says John Conkling, a pyrotechnic chemist at Washington College in Maryland. — Sarah Fecht



"punch posts" where they can let the large artillery fly. This year's biggest opening sequence came from Macedo's Pirotecnia, a Portuguese company that launched a barrage of shells that turned the entire sky red for the first 20 seconds.

Sweden's team punched in with ABBA's "Dancing Queen" and fireworks resembling a 1000-foot-tall Wurlitzer jukebox. Poland's Surex Fireworks launched blue fireworks from the pontoons; they skipped across the lake, reflecting off the surface as if it were a mirror. The French team, Brézac Artifices, used white and blue flares to create the illusion of a monument rising from the lake.

Canadian blogger Paul Marriott has reviewed 169 shows on his website devoted to the competition. "A fireworks show should be like a good roller coaster—there should be moments of building tension, climax and quiet," he says. "That said, there is a trend toward more and more firepower."

WESTERN ENTERPRISES is one of the last U.S. companies still making its own fireworks. They are beautiful, with tricky colors like dark cherry and pistachio green and names like Aqua Coconut Trees and Color-Changing Brocades. It's also one of the few specializing in close-proximity shells and

1 RED HEARTS

COLOR: Strontium compounds; burning them doesn't produce byproducts that weaken red like other colors.
EFFECT: To get novel shapes, stars are glued to paper in the desired pattern and surround the shell's black powder. The hard part, Conkling says, is getting the shell to burst when it's oriented correctly, preventing upside-down hearts or backward letters.

4 GOLDEN DRAGON EGGS

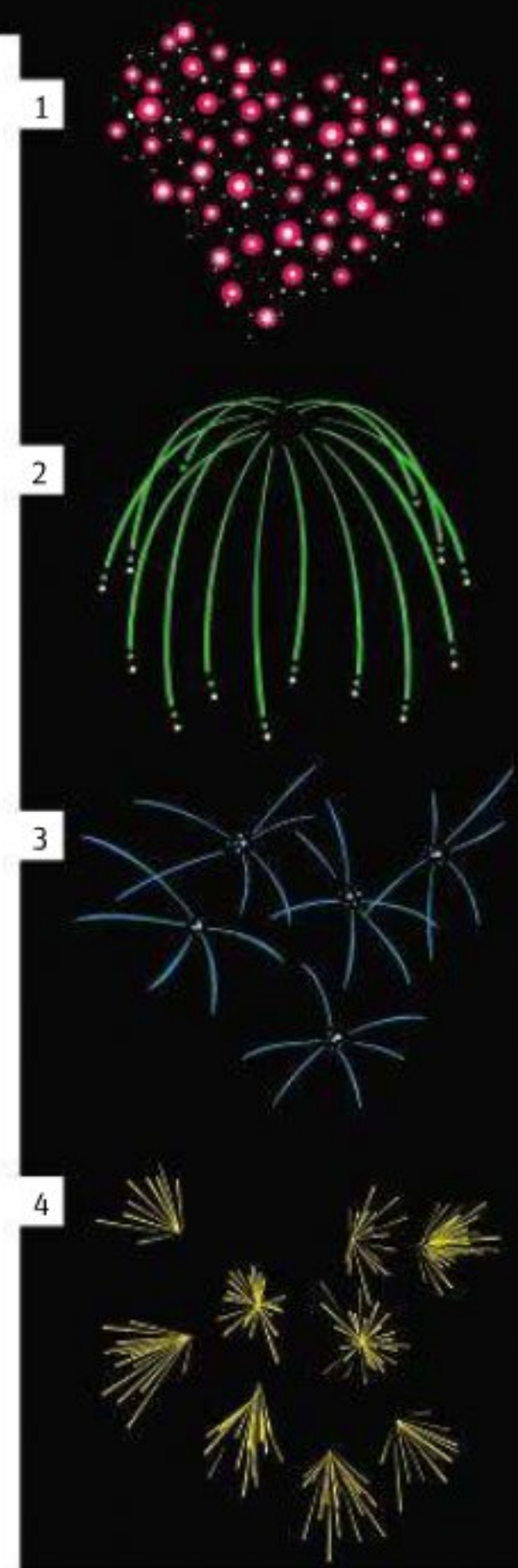
COLOR: Sodium compounds; the use of gold in fireworks dates from the Renaissance.
EFFECT: Dragon eggs are created with a bismuth metal compound, copper oxide and a magnesium-aluminum alloy. The mixture reacts very energetically, snapping against the surrounding atmosphere. "The air gets pushed back so quickly that it's breaking the sound barrier, which produces audible crackling," Conkling says.

2 GREEN WILLOWS

COLOR: Barium compounds; their chemical stability makes them easy to work with.
EFFECT: Pyrotechnicians create long-lasting sparklers by substituting charcoal for stars' metal fuels. Charcoal makes the barium burn slowly, creating the draping effect of the willow as the stars fall. For symmetry, stars must weigh nearly the same and be distributed evenly throughout the shell.

3 BLUE CROSSETTES

COLOR: Copper compounds; they have to burn at lower temperatures to remain stable, so blue light is less intense and more difficult to produce.
EFFECT: Each crossette shell contains paper-wrapped stars packed close to a black powder core. When the shell explodes, the primed end of each star ignites and burns toward its center, which contains a separate charge. That splits the star into burning fragments.



effects, which explode so low to the ground that the audience feels like it's in the middle of the show.

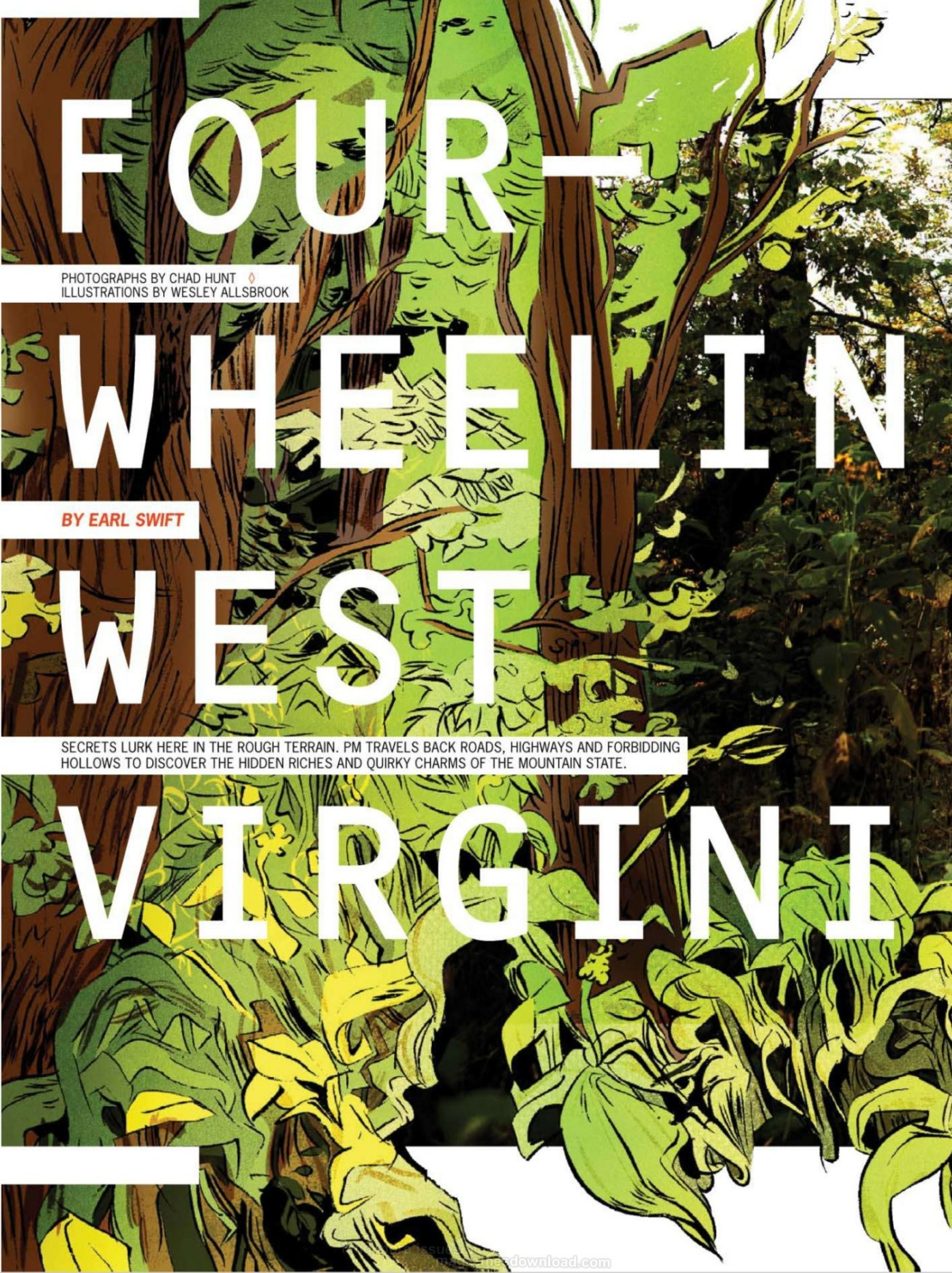
Because they're handmade, Western's shells cost four to five times as much as those manufactured in China. So while some competitors use the \$70,000 to bulk up on cheap firepower, the budget at La Ronde won't go nearly as far for Western.

"Good God, the Chinese stuff comes in so cheap, you can hardly compete," says Alan Johnson, Western's consulting chemist. "Companies come in here and bring the beef and try to blow everybody out of the water with just sheer power."

Caimano has always preferred to strive for artistry—matching the rhythm of fireworks to the pulse of music and cadence of poetry. He was born into one of America's oldest fireworks families, the Zambellis, and grew up learning the craft from his uncles after a shell killed his father, when Caimano was 5. "I think we all have this primal love for fire," he says. "It got into my blood before I even knew it."

With Pyro Spectaculars in California, Caimano co-produced shows for two summer Olympics. For nearly a decade he designed Macy's Fourth of July display in New York City. He lived in San Bernardino,

CONTINUED ON PAGE 124



FOUR

PHOTOGRAPHS BY CHAD HUNT ♦
ILLUSTRATIONS BY WESLEY ALLSBROOK

WHEEL IN

BY EARL SWIFT

WEST

SECRETS LURK HERE IN THE ROUGH TERRAIN. PM TRAVELS BACK ROADS, HIGHWAYS AND FORBIDDING HOLLOWS TO DISCOVER THE HIDDEN RICHES AND QUIRKY CHARMS OF THE MOUNTAIN STATE.

VIRGINIA



Never mind the boulders, fallen trees and lack of anything remotely resembling a road—the Jeep gamely blazes a trail of its own.

PM FREEDOM OF THE ROAD



G

A

W

E'RE DEEP IN AN ALLEGHENY FOREST, MILES FROM THE NEAREST BLACKTOP, when it occurs to me that we might be off track. Our GPS and topo map indicate a road, but we're half-buried in a thicket of wildflowers, greenbrier and fallen timber. If a path lies beneath our tires, it's a master of disguise. "We're done—time to turn around," says Chad Hunt, my co-pilot and photographer on this foray into West Virginia's mountain country. I climb out of the Jeep to get the lay of the land, as it were. Could the computer and our atlas be wrong?

I would feel panicked if not for two things. One, our 2011 Grand Cherokee Overland is the ironman of SUVs, luxe but seemingly unstoppable; two, we're facing the sort of quandary we hoped to encounter on this tour by gravel road, dirt road and no road at all. Chad

lives in New York City, and I near the naval yards in Norfolk, Va., and we both need a dose of Lewis and Clark. We have five days in a sweet ride to explore the grandest and the grittiest of eastern West Virginia's highlands.

Judging from my research, they haven't changed much since the 18th century, when Indians and Englishmen waged bloody war here—but right now I'm a fatter target for tick bites than musket balls. I climb back into the Jeep's plush cabin and shift into low gear, forging ahead in spite of Chad. Dangling vines snatch at the windshield. The underbrush sounds like surf beneath the skidplates. A limestone scarp rises through the trees on our left. Concerned that the driving situation has grown precarious, I stop and get out to do more scouting on foot. I soon see that we've run out of mountain, the ground ahead tipping into free-fall.

"Well," Chad sighs, as unkindly as one can sigh the word. "Like I said."

I turn the beast around—not easy, what with all the trees. I curse and whine, and later, hang my head in shame. Our forebears faced tomahawks, mine cave-ins and black lung. We, on the other hand, are coddled in soft leather. The 506-watt stereo is thumping. With the onboard 3G router, we could even Skype—to a search-and-rescue team, perhaps. To our moms.

OUR EXPEDITION STARTS IN MUCH cushier fashion, at the Greenbrier Resort in White Sulphur Springs, a five-star golf, hunting, fishing, equestrian and gambling retreat so vast that its main building requires 10 lobbies. The Grand Cherokee seems at home here. Under the hotel's mammoth portico, the blackberry pearl-coat paint and chrome grille gleam in the sun. Getting around the place is an aerobic undertaking, given the 100-yard corridors, sweeping outdoor promenades and oceanic lawns. But there's even more to the Greenbrier than meets the eye. A tour guide leads Chad and me past false walls and a steel blast door into a fallout shelter built for Congress dur-

ing the Cold War, a top-secret refuge in which 1100 Washington insiders could have ducked a nuclear holocaust for six weeks or better, shrouded by reinforced concrete up to 5 feet thick. The U.S. Government Relocation Facility isn't opulent—we're talking linoleum floors and bunk beds—but its size is jaw-dropping, as is the fact that it remained on the q.t. until 1992, when the *Washington Post* blew its cover and the feds decommissioned the complex.

Even if it were closer to D.C., in a well-to-do neighborhood, I would have trouble wrapping my head around this den worthy of Dr. Strangelove. But here in hardscrabble West Virginia—in the

The Jeep whizzes past a wind farm near Thomas. Each of the 220-foot-tall turbines can generate 1.5 megawatts of electricity.

palace known as the Greenbrier—the bunker seems downright surreal.

AFTER EXTRICATING OURSELVES from 300-thread-count sheets and downing omelets at the \$26 breakfast buffet, Chad and I motor south, in search of terrain rugged enough to challenge the Jeep. We find it just outside the Greenbrier's gates, on Kate's Mountain Road, named for one Kate Carpenter. In 1756, after Indians killed her husband, she fled this way with her infant daughter, seeking refuge on the rocky hill that now bears her name. A half-mile up the road, blacktop gives way to wriggling gravel. As I steer through blind switchbacks, I ask Chad how he thinks we'd have fared against the Shawnee. "That depends on whether we would've had the Jeep," he says with his usual even delivery.





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The Grand Cherokee (never mind the coincidence of the name) handles the loose road surface as if it were smooth asphalt, so we aim for something tougher—and find it on a tractor path that dives off a ridge top into dense woods. The Jeep transitions from on- to off-road via its Selec-Terrain system (at right). After I dial in “sand/mud,” the SUV rises up on its haunches and we thump downhill. Limbs of beech and oak crack beneath the tires. Tree trunks loom inches from the sides of the truck’s broad snout. For all its luxurious appointments, this vehicle isn’t afraid to get some dirt under its nails. We break trail on a GPS route between two of the state’s 17 covered bridges (the oldest dates to 1852). The Jeep is untaxed by all that we encounter, which makes for some oddly laid-back four-wheeling. Chad channel-surfs the stereo, and I, mesmerized by the scenery, feel as relaxed as I did while savoring that omelet at the Greenbrier.

About 40 miles from the hotel, in Talcott, population 1160, we stop to pay our respects to John Henry. Tradition holds that here, at the abandoned Great Bend Tunnel, the mighty steel-driver beat a steam drill in an 1872 race to excavate rock. Today, the tunnel floor is filled with water, the mouth blocked by limestone slabs. A newer, bigger tunnel punches through the mountain nearby, and while we linger there, four trains rumble through, two pulling cars piled high with coal, two empty and bound for the mines. Coal has driven West Virginia’s economy for 150 years; the black gold lies beneath all but two of its 55 counties, directly employs 30,000 people and generates 99 percent of the state’s electricity. In fact, West Virginia produces more coal than any state except Wyoming. Back underway, Chad and I are bombarded with clues to the fuel’s importance here. On the courthouse lawn in tiny Webster Springs, we stop to photograph a coal nugget the size of a love seat; the plaque says it was mined in 1930. It’s a monument—to coal.

JEEP'S OFF-ROAD GEAR

The Grand Cherokee effortlessly slides between two seemingly opposing worlds—the highbrow Greenbrier lifestyle and West Virginia’s mud and guts—with a combination of mechanical hardware and electronic tech. Here’s how:



QUADRA-DRIVE II Jeep’s top-of-the-line 4x4 system uses electronically controlled center and rear differentials to direct engine torque to the wheels with the most traction. The system is aided by electronic traction control that individually brakes a spinning wheel, and hill-descent control, which automatically operates the brakes to control downhill speed. If all that’s not enough, QDII also features a 2.72:1 low-range crawling gear.

QUADRA-LIFT AIR SUSPENSION Off-road, you want lots of ground clearance and generous approach and departure angles. But that height kills pavement handling and fuel economy. The Grand Cherokee features air springs at all four corners. A compressor mounted near the right front tire inflates the airbags to raise the ground clearance from 8.1 inches up to 10.7. When cruising on the highway, the system automatically lowers the vehicle 0.6 inches to decrease aero drag. There’s even a “park” mode that drops the SUV farther to make loading easier.

SELEC-TERRAIN Can’t decide how to operate all these systems? There’s a rotary knob on the center console for that. Simply select the type of terrain—sand/mud, snow, rock, auto or even sport—and the computer takes care of the rest, juggling throttle response, traction control and suspension height to get the most from the Jeep’s driveline.

In Bluefield, we witness the industry in all its gritty glory. The town rises in terraced hillsides above a rail yard 20 tracks wide. Cars heaped with black nuggets wait in mile-long chains for the journey to the Atlantic. We stand on an ancient iron bridge over the tracks as locomotives rumble beneath us. It strikes me as both a scene from the past and a reminder that today, while the energy discussion encompasses

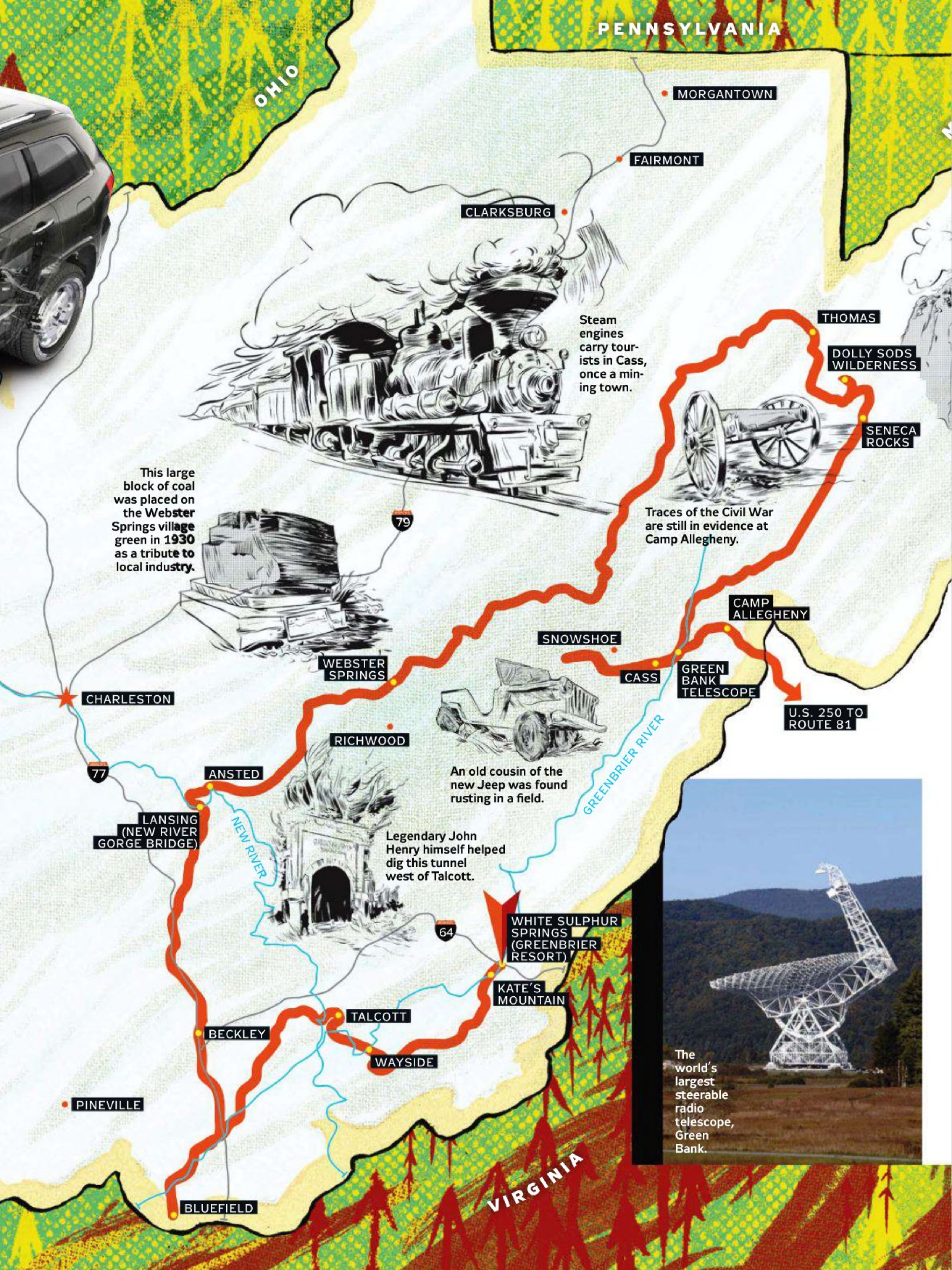
CONTINUED ON PAGE 84

Up and Down the Mountain State

The terrain of one-quarter of West Virginia’s 15.4 million acres exceeds a grade of 40 percent, an angle that would earn a ski slope a black-diamond rating.

→ → →

PENNSYLVANIA



MORGANTOWN

FAIRMONT

CLARKSBURG

Steam engines carry tourists in Cass, once a mining town.

THOMAS

DOLLY SODS WILDERNESS

SENECA ROCKS

Traces of the Civil War are still in evidence at Camp Allegheny.

CAMP ALLEGHENY

SNOWSHOE

CASS

GREEN BANK TELESCOPE

U.S. 250 TO ROUTE 81

This large block of coal was placed on the Webster Springs village green in 1930 as a tribute to local industry.



WEBSTER SPRINGS

CHARLESTON

77

LANSING (NEW RIVER GORGE BRIDGE)

ANSTED

NEW RIVER

RICHWOOD



An old cousin of the new Jeep was found rusting in a field.

GREENBRIER RIVER

Legendary John Henry himself helped dig this tunnel west of Talcott.



64

WHITE SULPHUR SPRINGS (GREENBRIER RESORT)

KATE'S MOUNTAIN

TALCOTT

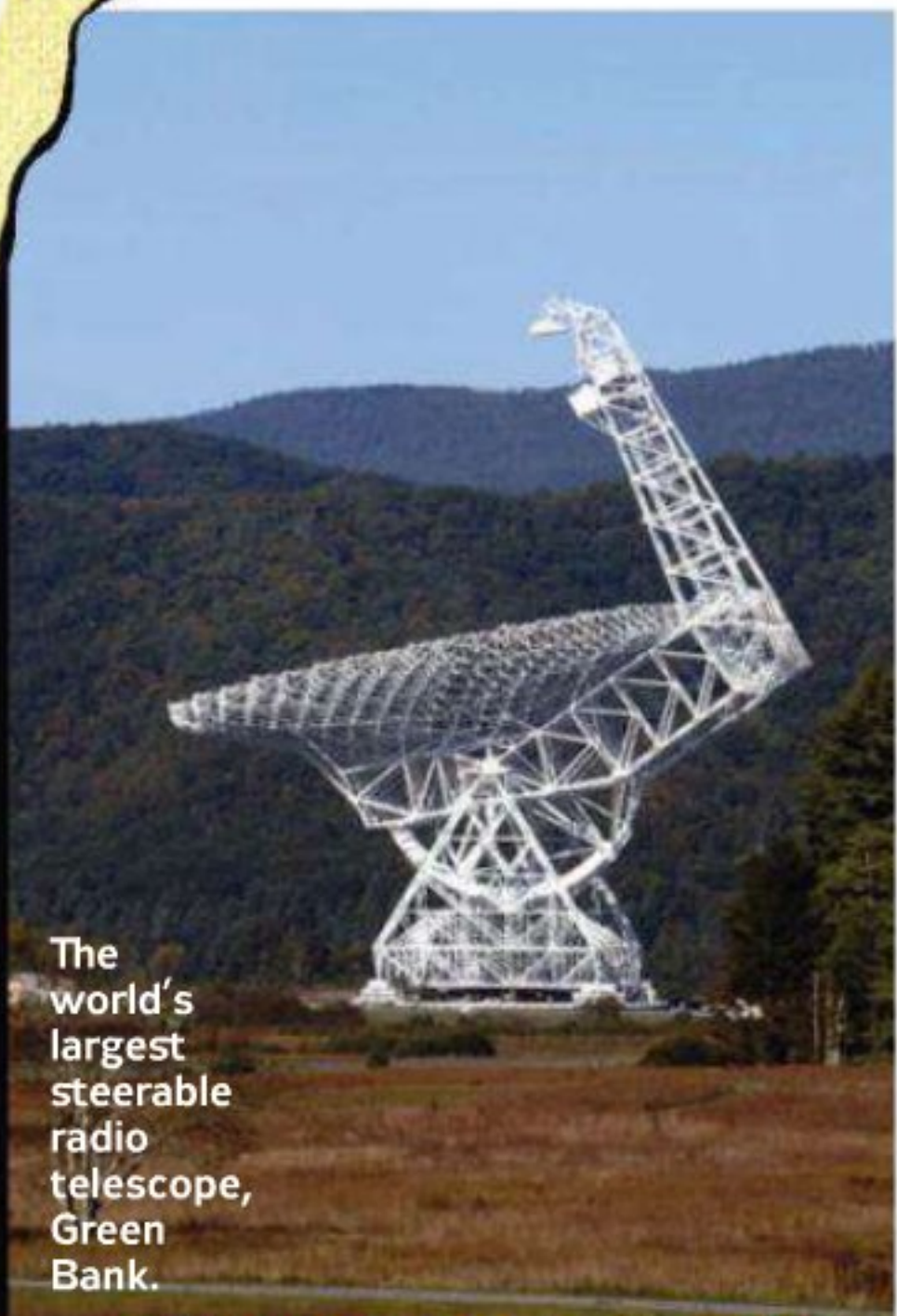
BECKLEY

WAYSIDE

PINEVILLE

BLUEFIELD

VIRGINIA



The world's largest steerable radio telescope, Green Bank.

The Grand Cherokee (never mind the coincidence of the name) handles the loose road surface as if it were smooth asphalt, so we aim for something tougher—and find it on a tractor path that dives off a ridge top into dense woods. The Jeep transitions from on- to off-road via its Selec-Terrain system (at right). After I dial in “sand/mud,” the SUV rises up on its haunches and we thump downhill. Limbs of beech and oak crack beneath the tires. Tree trunks loom inches from the sides of the truck’s broad snout. For all its luxurious appointments, this vehicle isn’t afraid to get some dirt under its nails. We break trail on a GPS route between two of the state’s 17 covered bridges (the oldest dates to 1852). The Jeep is untaxed by all that we encounter, which makes for some oddly laid-back four-wheeling. Chad channel-surfs the stereo, and I, mesmerized by the scenery, feel as relaxed as I did while savoring that omelet at the Greenbrier.

About 40 miles from the hotel, in Talcott, population 1160, we stop to pay our respects to John Henry. Tradition holds that here, at the abandoned Great Bend Tunnel, the mighty steel-driver beat a steam drill in an 1872 race to excavate rock. Today, the tunnel floor is filled with water, the mouth blocked by limestone slabs. A newer, bigger tunnel punches through the mountain nearby, and while we linger there, four trains rumble through, two pulling cars piled high with coal, two empty and bound for the mines. Coal has driven West Virginia’s economy for 150 years; the black gold lies beneath all but two of its 55 counties, directly employs 30,000 people and generates 99 percent of the state’s electricity. In fact, West Virginia produces more coal than any state except Wyoming. Back underway, Chad and I are bombarded with clues to the fuel’s importance here. On the courthouse lawn in tiny Webster Springs, we stop to photograph a coal nugget the size of a love seat; the plaque says it was mined in 1930. It’s a monument—to coal.

JEEP'S OFF-ROAD GEAR

The Grand Cherokee effortlessly slides between two seemingly opposing worlds—the highbrow Greenbrier lifestyle and West Virginia’s mud and guts—with a combination of mechanical hardware and electronic tech. Here’s how:



QUADRA-DRIVE II Jeep’s top-of-the-line 4x4 system uses electronically controlled center and rear differentials to direct engine torque to the wheels with the most traction. The system is aided by electronic traction control that individually brakes a spinning wheel, and hill-descent control, which automatically operates the brakes to control downhill speed. If all that’s not enough, QDII also features a 2.72:1 low-range crawling gear.

QUADRA-LIFT AIR SUSPENSION Off-road, you want lots of ground clearance and generous approach and departure angles. But that height kills pavement handling and fuel economy. The Grand Cherokee features air springs at all four corners. A compressor mounted near the right front tire inflates the airbags to raise the ground clearance from 8.1 inches up to 10.7. When cruising on the highway, the system automatically lowers the vehicle 0.6 inches to decrease aero drag. There’s even a “park” mode that drops the SUV farther to make loading easier.

SELEC-TERRAIN Can’t decide how to operate all these systems? There’s a rotary knob on the center console for that. Simply select the type of terrain—sand/mud, snow, rock, auto or even sport—and the computer takes care of the rest, juggling throttle response, traction control and suspension height to get the most from the Jeep’s driveline.

In Bluefield, we witness the industry in all its gritty glory. The town rises in terraced hillsides above a rail yard 20 tracks wide. Cars heaped with black nuggets wait in mile-long chains for the journey to the Atlantic. We stand on an ancient iron bridge over the tracks as locomotives rumble beneath us. It strikes me as both a scene from the past and a reminder that today, while the energy discussion encompasses

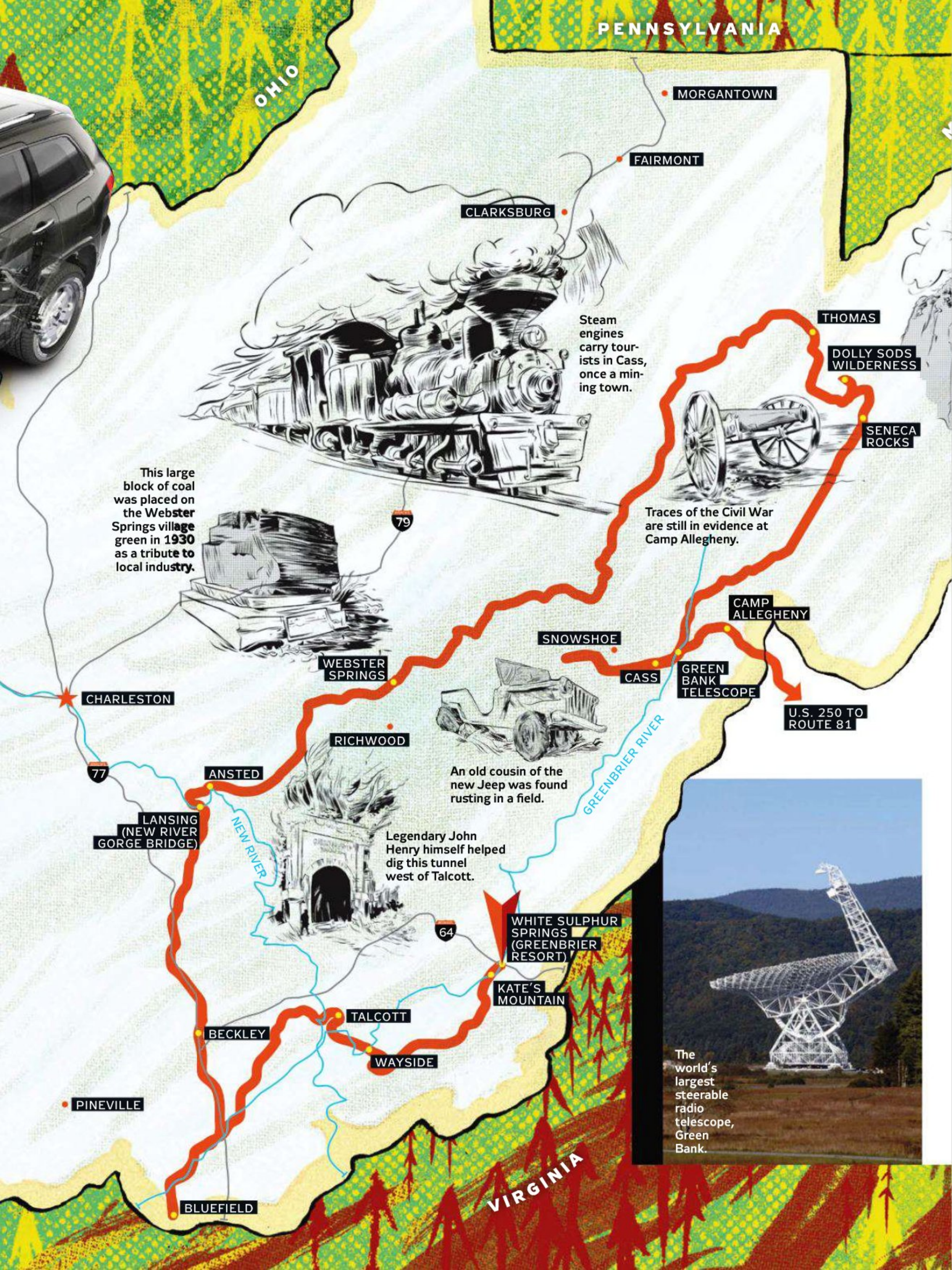
CONTINUED ON PAGE 84

Up and Down the Mountain State

The terrain of one-quarter of West Virginia’s 15.4 million acres exceeds a grade of 40 percent, an angle that would earn a ski slope a black-diamond rating.

→ → →

PENNSYLVANIA



MORGANTOWN

FAIRMONT

CLARKSBURG

Steam engines carry tourists in Cass, once a mining town.

THOMAS

DOLLY SODS WILDERNESS

SENECA ROCKS

Traces of the Civil War are still in evidence at Camp Allegheny.

CAMP ALLEGHENY

SNOWSHOE

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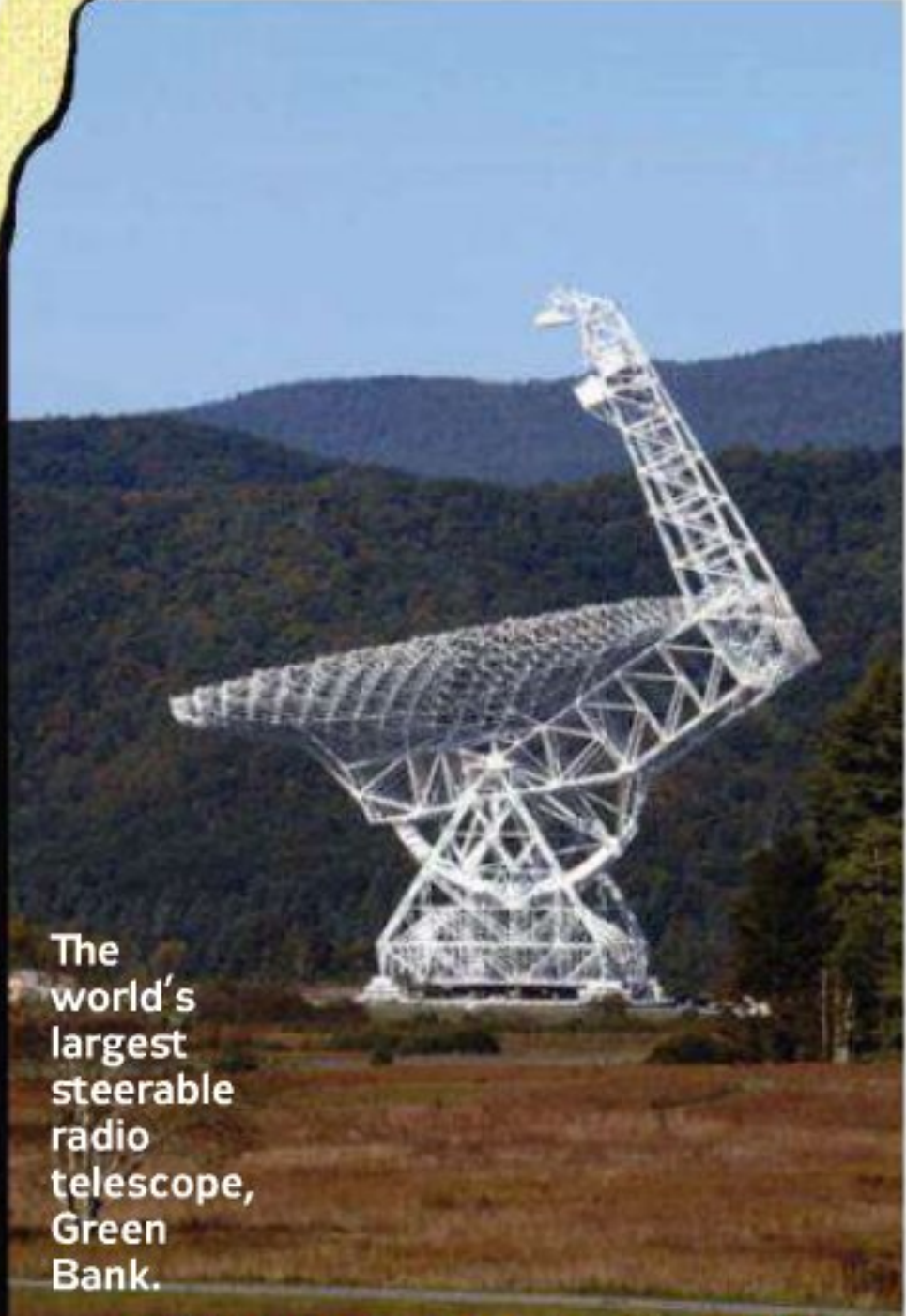
BECKLEY

WAYSIDE

PINEVILLE

BLUEFIELD

VIRGINIA



The world's largest steerable radio telescope, Green Bank.

MARYLAND

MARTINSBURG

GET THERE : WEST VIRGINIA

The Seneca Rocks draw climbers from the U.S. and abroad.

When it was completed in October 1977, the New River Gorge Bridge was the largest steel-arch bridge in the world, at 3030 feet long. The 2011 Bridge Day Festival, on Oct. 15, features base jumping and rappelling from the 876-foot-high deck.

Rafting on the New River Gorge National River.

Driving through West Virginia, both on- and off-road, is a revelation. The state is packed with more action sports, fascinating history and rural hamlets than one can imagine. Here's a quick look at ways to enjoy the natural beauty within the Mountain State's borders.

EXPLORE THE UNDERGROUND

Beckley
King Coal dominates the region, so a mine tour is a must. The Beckley Exhibition Coal Mine Tour carries visitors down 1500 feet in an authentic coal-mining railcar. 304-256-1747; beckley.org

CATCH AND RELEASE

Richwood
The Cranberry and Williams rivers are tributaries of the Gauley, and both

offer excellent trout-fishing opportunities. The streams are open to anglers year-round, but the best action is from March through May, when the swirling currents are restocked each week with rainbow, brook and brown trout—and the elusive Centennial golden trout. 304-846-2596; richwoodwv.com/troutfish.html

GLIDE IN THE TREES

Lansing
The TreeTops

Canopy Tour in the New River Gorge strings together 10 ziplines and five suspension bridges to complete a mile-long treetop tour. Start to finish, the course takes about 3 hours, during which you'll soar among old-growth hemlocks and hardwoods, reaching heights of 200 feet and speeds of 45 mph or more. 304-574-0704; newrivergorgecanopytour.com

MOTOR IN THE WOODS

Pineville
Explore 80 miles of the Pinnacle Creek Trail System on your motorcycle, ATV or UTV. Like ski slopes, the routes are marked according to their difficulty level. They snake up

the mountains to scenic lookouts. Don't have a ride? Several local outfitters rent machines and gear. Also, there are half a dozen similar riding areas throughout the state. 800-592-2217; trailsheaven.com

GO UP, WAY UP

Seneca Rocks
Rising 900 feet above the valley floor, Seneca Rocks is one of the more diverse climbing spots in the East. There are routes among the jagged outcroppings to challenge expert climbers, as well as easier courses where novices can learn the ropes, so to speak. *Seneca Rocks Mountain Guides*; 304-567-2115; senecarocks.com

GRAVITY FEED

Snowshoe
Snowshoe Mountain peaks at nearly a mile above sea level and has 1500 vertical feet of the best skiing in the mid-Atlantic. There may be better slopes in the Rockies, but Snowshoe is a mere 4½-hour drive from Washington, D.C., and an average of 15 feet of snow falls on and around the mount every winter. When warmer temperatures arrive, in May, the resort

offers top-tier downhill bike runs. 304-572-4636; snowshoemtn.com

GET STEAMED

Cass
Hop aboard a steam locomotive and ride into a loggers' camp—and even put up for the night in restored workers' housing in this once-grand lumber town. 304-456-4300; cassrailroad.com

CONTINUED FROM PAGE 80

wind, solar and much more, coal is still king in Appalachia.

EARLY THE NEXT MORNING, I immerse myself in another industry for which the state is renowned: I climb into an eight-person rubber raft to run the dam-fed Lower Gauley River, which churns hell-for-leather through an all-day whitewater roller coaster. Staying put is no easy task: The raft slides fast as a racehorse into huge standing waves, which it meets with explosions of spray; it dives into swirling holes of froth so deep that the river rises over our heads; it spins sideways against boulders, leaps through chutes, and tosses us every which way as it twists and banks through rapids that roar like the Superdome.

Water sometimes slams me flat onto my back. One wave snatches up a paddle—whether mine or a neighbor's I can't say—that spears my thigh; I'm destined to limp for days. Still, I'm sorry the trip ends. That night, exhausted and bruised, I'm asleep before I turn out the light at the Hawks Nest State Park Lodge in Ansted. Only with morning do I discover the view from the lodge's patio, which overhangs the New River Gorge from a rocky parapet 585 feet over the water: mountain on mountain, shrouded in a blue-gray haze,

and hardly any sign of modern civilization.

Fueled up on coffee, Chad and I strike out northeast on two-laners and dirt roads, with wooded slopes rising steeply around us and shrouding us in shadow for hours. Our destination: the Dolly Sods Wilderness, known for a subarctic landscape out of place by 1600 miles; its lichens and mosses, cranberry and red spruce are typically found in the Canadian high country. A cratered gravel road delivers us onto the eastern continental divide, where we marvel at the preserve's weird jumble of sandstone boulders, its boggy heaths and 20-mile views.

We stop briefly in the town of Thomas, once a mining center, now popular with mountain bikers. Wandering the main drag, I come across a young, bearded local named John Bright on the porch of a hostel.

"So, what do people do around here?" I ask.

"They drink beer and listen to music at the Purple Fiddle," he replies, pointing to the tavern next door.

North Carolina native Absher built this store near Ansted in 1935. He lived upstairs with his family and did business on the first floor.



"What do they do when they're not doing that?" I ask.

"Oh, that's pretty much what they do," he says.

"Well, how do they make money to go to the Purple Fiddle?" I press.

"The prices at the Purple Fiddle are very reasonable," he replies.

I ask how he makes his living.

"I sit here," Bright says, "and I run the Purple Fiddle."

ON THE LAST DAY OF OUR TRIP, we plot an exit strategy worthy of the journey—and of the Jeep. Near Cass our topo map shows a thin trail called Buffalo Mountain Road, leading into Virginia, where we'll pick up interstates back to our busy city lives. We lock in the trail on the GPS. This time, the device leads us past an open barn where a farmer is listening to talk radio, then across a sodden cow pasture. "I think it's a safe rule," Chad says as we scatter the herd, "that when you can reach out and actually touch a cow, you're no longer on a road."

Doubling back, we see the farmer churning toward us on a tractor, his face grim. I lower my window as we pull alongside, ready for an earful. First thing he says is, "GPS?"

He helps us plot a new course via a narrow dirt road a few miles away. It turns out to be an ancient turnpike that climbs through a forgotten Civil War battlefield. We stop for a break and discover that we've unwittingly climbed onto an old Confederate gun emplacement. It is further evidence that in West Virginia, the past is always close by.

The same is true of the Jeep. Early in our tour, we spied a CJ-3A consumed by weeds in a meadow—60 years old, its paint sun-bleached and its interior ravaged by rust. Our swanky SUV seems to have as much in common with that abandoned old workhorse as the Greenbrier has with the rest of West Virginia. But that assessment is unfair—in fact, it's flat-out wrong. The Grand Cherokee has proved gutsy and can-do on all sorts of terrain. In creature comforts it might be a gentleman's car, but in its bones it remains a Jeep. It, too, holds tight to the past. **PM**



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LESSONS FROM **JAPAN**

AN EPIC EARTHQUAKE
AND TSUNAMI
LEAVE HARD-WON
KNOWLEDGE IN
THEIR AFTERMATH.



BY CARL HOFFMAN



MARCH 11, 2011
MAGNITUDE 9.0
EARTHQUAKE

A TSUNAMI DEMOLISHED DOWNTOWN RIKUZENTAKATA IN LESS THAN AN HOUR.



A well-paved two-lane road along Japan's northeast coast winds

through the mountains, gradually descending toward Rikuzentakata. The seaside city, population 23,000, once attracted tourists and elderly Japanese with its gorgeous views and idyllic beaches. A river plunges down short,

steep slopes through the town and into the sea.

At the end of March, a week after a magnitude 9.0 earthquake rocked the region, the trees along the road are ready for the first bud of spring. A banal landscape of suburbia passes: homes

PHOTOGRAPH BY Q. SAKAMAKI

FIREFIGHTERS FROM THE INLAND CITY OF SAITAMA WERE THE FIRST EMERGENCY WORKERS TO REACH RIKUZENTAKATA. THE NORMALLY 6-HOUR DRIVE TOOK 18. THE LESSON: DURING A DISASTER, THE PUBLIC MUST BE READY TO CARE FOR THEMSELVES.



with children's bicycles on porches. The parking lot of a 7-Eleven is filled with cars, but its gas station has no fuel.

And then the road descends into downtown Rikuzentakata—and a world crushed. A sickly brown-gray carpet of rubble stretches to the horizon, dotted with bright-red front-end loaders and firetrucks. A few random concrete buildings are still standing, shattered windows gaping, facades strewn with tree limbs and fishing nets. Cadres of responders wearing helmets and face masks advance in slow-moving lines, probing the debris field with long poles. They are looking for the dead.

The mechanics of the disaster are well-known to the world: A massive earthquake, 80 miles offshore, produced the tsunami that struck this and other coastal cities. Seeing it firsthand is overwhelming. Rikuzentakata has been reduced to 4 square miles of broken wood and twisted steel beams. Evidence of ruined lives is everywhere. Flattened trucks, flipped upside down. A

man's tie in a tree. Photo albums in the mud. A bowl. A sodden teddy bear.

Takehiro Shimamura, a firefighter from the inland city of Saitama, was among the first emergency personnel to enter the city. "People in the high places were crying, in shock with their mouths hanging," he says. "Along the river we found no one alive, not a person."

Experts consider Japan's disaster planning and infrastructure the best in the world. This assessment proved correct when it came to preventing death and damage from the earthquake, the fourth largest ever recorded. The resultant tsunami, however, killed more than 25,000 people, despite the extensive protection built along the east coast.

The destruction taught the world that preparedness is as much a matter of education as of infrastructure. The tsunami was pitiless. For those who

knew what to do, survival was possible, but those who hesitated died. "The ones who survived in Japan are the ones who went to higher ground, period," says Patrick Corcoran, a hazards outreach specialist at Oregon State University. "Do *you* know where the higher ground is right now?"

• •

On the afternoon of March 11, Masako Tanaka was in Kesennuma, a coastal city 13 miles south of Rikuzentakata. The 57-year-old was making one of her periodic visits to her native Japan from her home in Los Angeles.

Tanaka and her 70-year-old aunt were near Kesennuma's port when the ground started rumbling. The tremors lasted 6 minutes. "The road was moving like a wave," she says. "We did not even know if the tsunami was coming right away or not, but somehow I felt that this earthquake was like nothing I had ever experienced in my life."

During the quake, Japan's skyscrapers swayed like bamboo trees in the

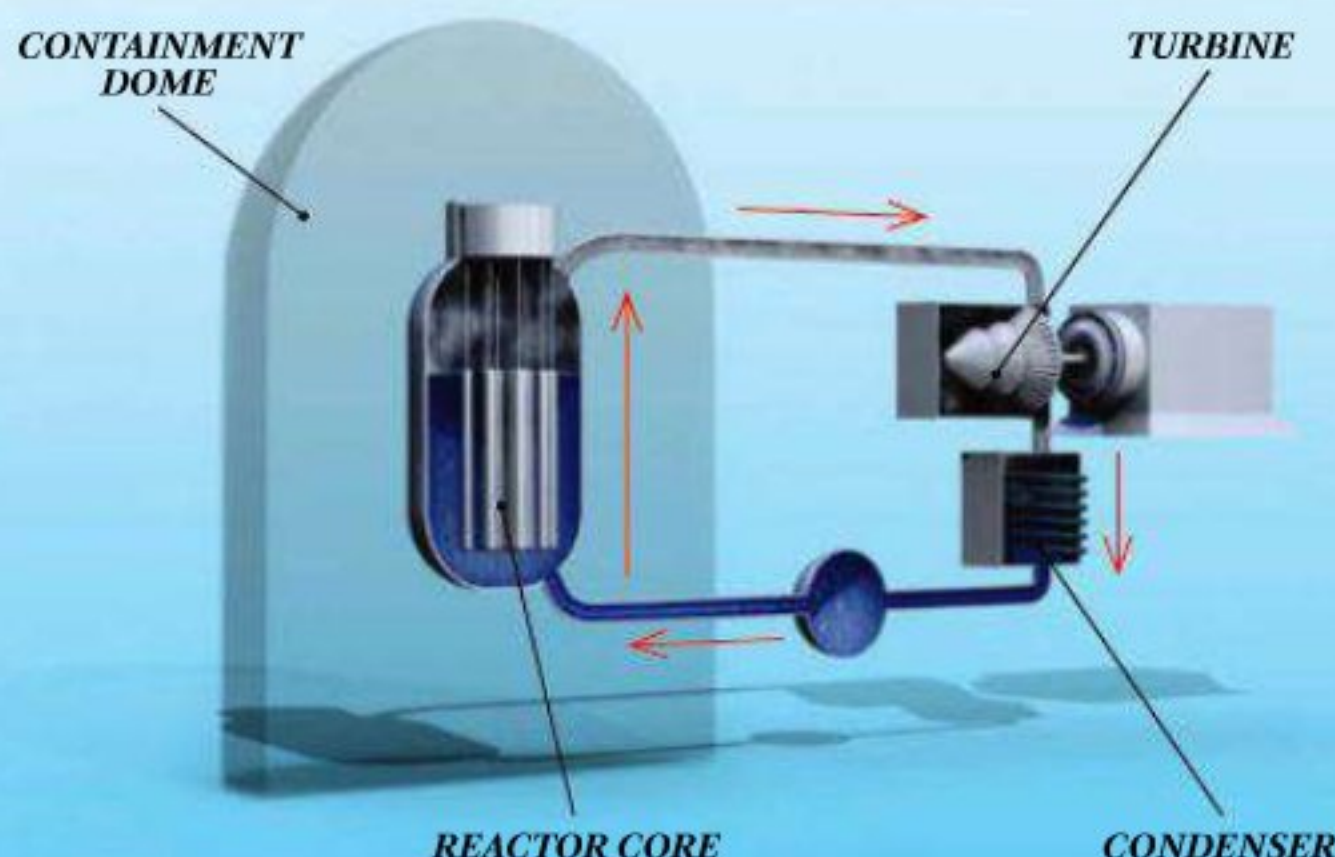
READY FOR THE WORST?

Japan and the U.S. have different approaches to infrastructure that can mean life or death during a natural disaster.

JAPAN

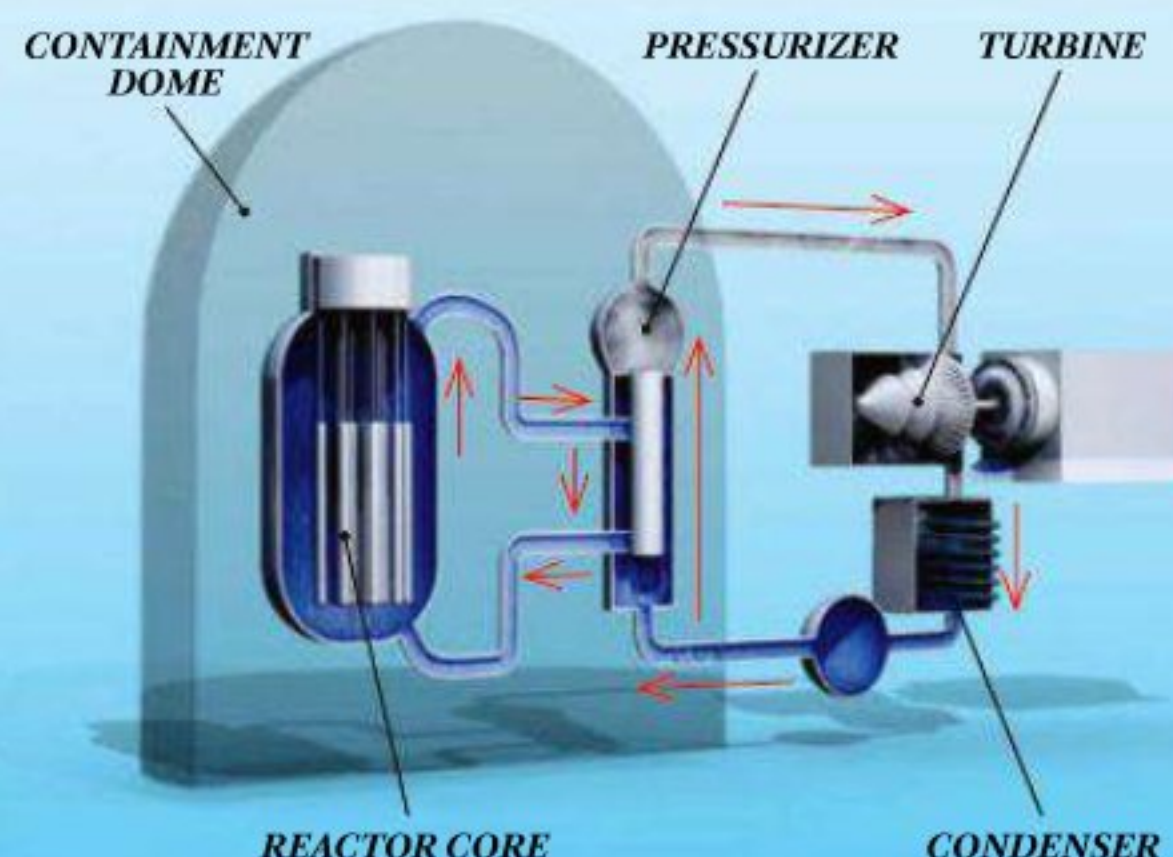
NUCLEAR POWER

- ① Japanese plants typically have multiple reactors. Having more reactors in one facility means more hazardous fuel stored on-site and greater risks in the event of a plant-wide incident.
- ② Japanese plants can't safely vent hydrogen. Uncooled fuel rods in a damaged reactor produce hydrogen, but many plants have no way to release the gas outside the reactor buildings before it reaches explosive levels, as happened in March.
- ③ Half of the nation's nuclear plants have boiling-water reactors. BWRs use the same water to cool the core as to turn the steam turbines, allowing radioactive leaks in the water to travel through the plant.



UNITED STATES

- ① American power plants have fewer nuclear reactors, making a plant-wide incident easier to manage. No existing facility in the U.S. has more than three reactors, although one in Georgia will soon have four.
- ② U.S. plants can vent hydrogen into the atmosphere. U.S. reactors have stacks that release the gas outside the building, reducing concentrations below explosive levels, says Ken Brockman, former director of safety for the International Atomic Energy Agency.
- ③ Of the 104 reactors in the U.S., only 35 are BWRs. Most are pressurized water reactors that have two separate loops of water, one to create steam and another to cool the reactor. This removes a potential path for radiation to spread.



TRAINS

Seismometers relay messages to transformers to command trains to stop during a quake. L-shaped guides mounted on cars can safely halt derailed wheels.

Most trains and tracks outside California aren't equipped with automatic-shutdown quake sensors, but many trains can detect broken rails and stop.

EARLY-WARNING SYSTEMS

Thousands of sensors detect a quake's primary waves (P-waves), which travel at the speed of sound but cause little damage. The dangerous surface waves (S-waves) arrive later.

The nation's Advanced National Seismic System, a network of P-wave and S-wave detectors, is only 25 percent complete. California's warning system could be completed in five years.

wind, but did not fall. "The biggest take-away," says Bozidar Stojadinovic, professor of civil and environmental engineering at University of California, Berkeley, "is that modern building codes worked."

Japan's codes are strict, but developers often go further than regulations demand, fitting buildings with devices that act like giant shock absorbers. "Developers are eager to deploy technology because Japanese will pay more money to live in a building with seismic isolators," Stojadinovic says.

In the United States, the focus on preparation is more lax, even in the

quake-prone areas of the Pacific Northwest. There, the onus of protection falls on property owners. Local governments often encourage safeguards but do not mandate them. For example, Seattle offers classes on bolting wood-frame homes to their foundations and securing water heaters, safeguards required by most insurance companies before they will issue earthquake protection.

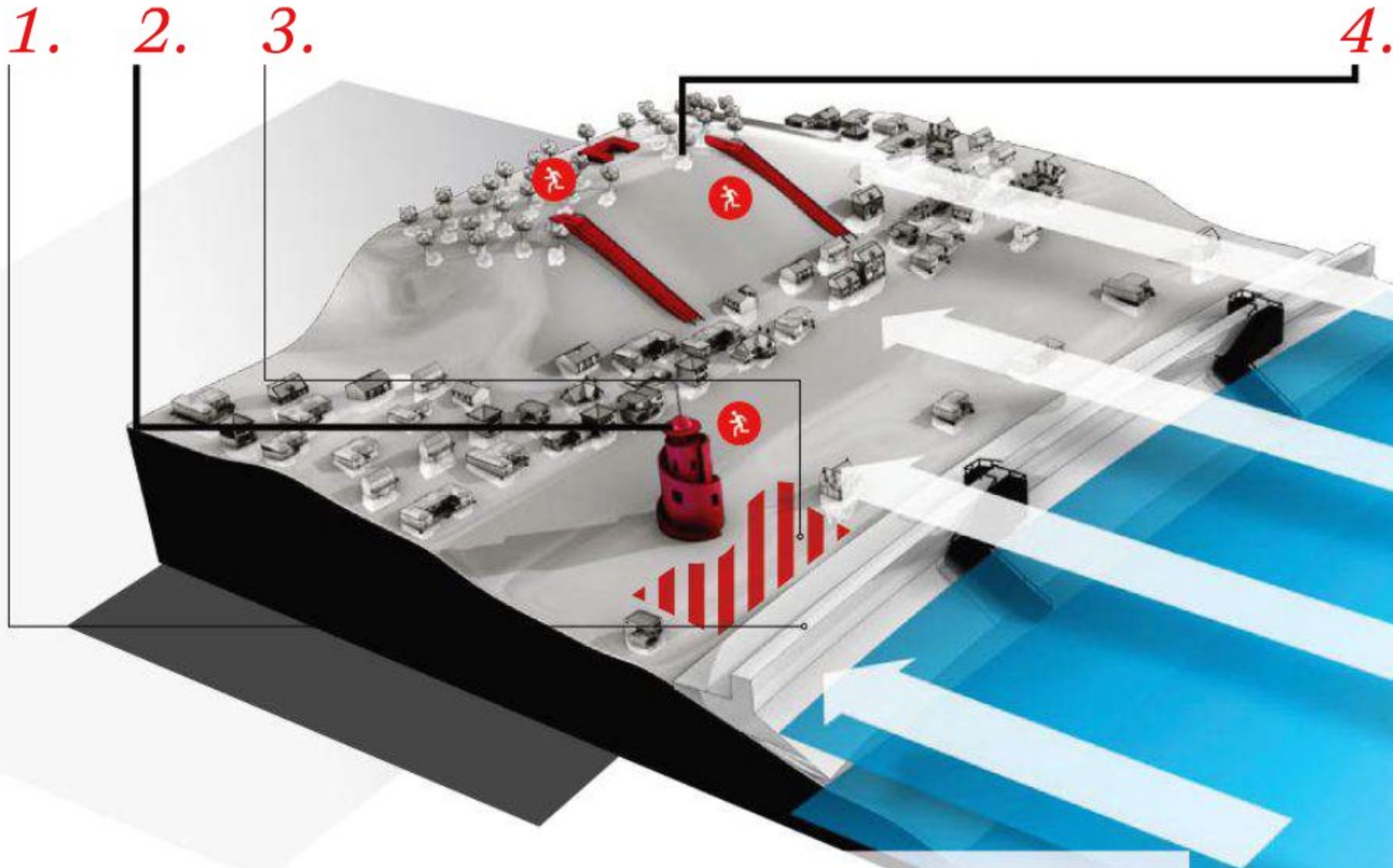
Experts say that residents don't

acknowledge the risk, and the area is not as prepared as Japan. "Many structures in the Pacific Northwest are not built to earthquake-resistant standards," says University of California, Irvine, public health expert Lisa Grant Ludwig. "There's a lot of brick, and it's a challenging problem."

Public infrastructure is another matter. Portland, Ore., recently installed lateral support walls in and reinforced the brick exteriors of its schools; this year (as PM went to press), voters weighed in on a \$548 million bond that would rebuild nine schools to national seismic

THE DEFENDED COASTLINE

When it comes to thwarting tsunamis, layers of protection are best.



1. RAISE WALLS

When a wave breaches a seawall—a high-profile and expensive defense—many call this a total failure. “Obviously, the smaller the wave, the better,” says researcher Mary Beth Oshnack. “But even if the seawall is shorter than the wave, it would still reduce the force of the wave.” The biggest problem with seawalls is that they tend to breed complacency. No wall can be expected to defeat every tsunami, and plans must be made for more layers of preparedness onshore.

2. CONSTRUCT TOWERS

Damage-resistant shelters can be constructed on high ground, providing a beacon for those fleeing an incoming wave. One such 786-square-foot shelter, in Nishiki, Japan, doubles as a disaster archive. Other Japanese emergency facilities flooded during March’s disaster—a grim reminder to model a wave’s potential path before construction. There are no such tsunami shelters in the U.S., but Cannon Beach, Ore., is considering building its town hall to double as one.

3. DON’T BUNCH UP

“There is a saying that ‘disaster happens when people forget,’” says Futoshi Toba, mayor of Rikuzentakata. “Maybe we can make new concrete homes in higher places.” Japan’s coastline is crowded: Very little of the nation is suitable for residential housing. Not so in the United States, where local authorities can zone larger plots to diminish the number of people living in danger areas. Zoning large plots would also decrease the amount of damaging debris pushed inland by a tsunami.

4. BUILD HIGH GROUND

Engineering well-marked, easy-to-access hills in tsunami-prone areas gives residents a familiar place to shelter and eases escape-route crowding. Hydrodynamists can simulate a tsunami’s potential reach, aiding the engineering and placement of such safe areas. As a bonus, these refuges can double as public parks.

safety standards.

These actions are prompted by a grim reality: An earthquake in the Pacific Northwest is not only expected, it’s likely. The subduction fault running from Northern California to Vancouver Island moves an average of once every 150 years. The most recent large quake occurred in January 1700—making the region 161 years overdue.

The tsunami that destroyed Rikuzentakata and Kesennuma began when the earthquake pushed a 185-mile-long, 90-mile-wide section of seafloor up about 130

feet. The water displaced by this rupture raced east, its energy dissipating into the Pacific, and west toward the northeast coast of Japan.

Japan’s early warning network blared across public address systems and flashed on the screens of computers and mobile electronics. This automated system is faster and wider-reaching than any U.S. equivalent.

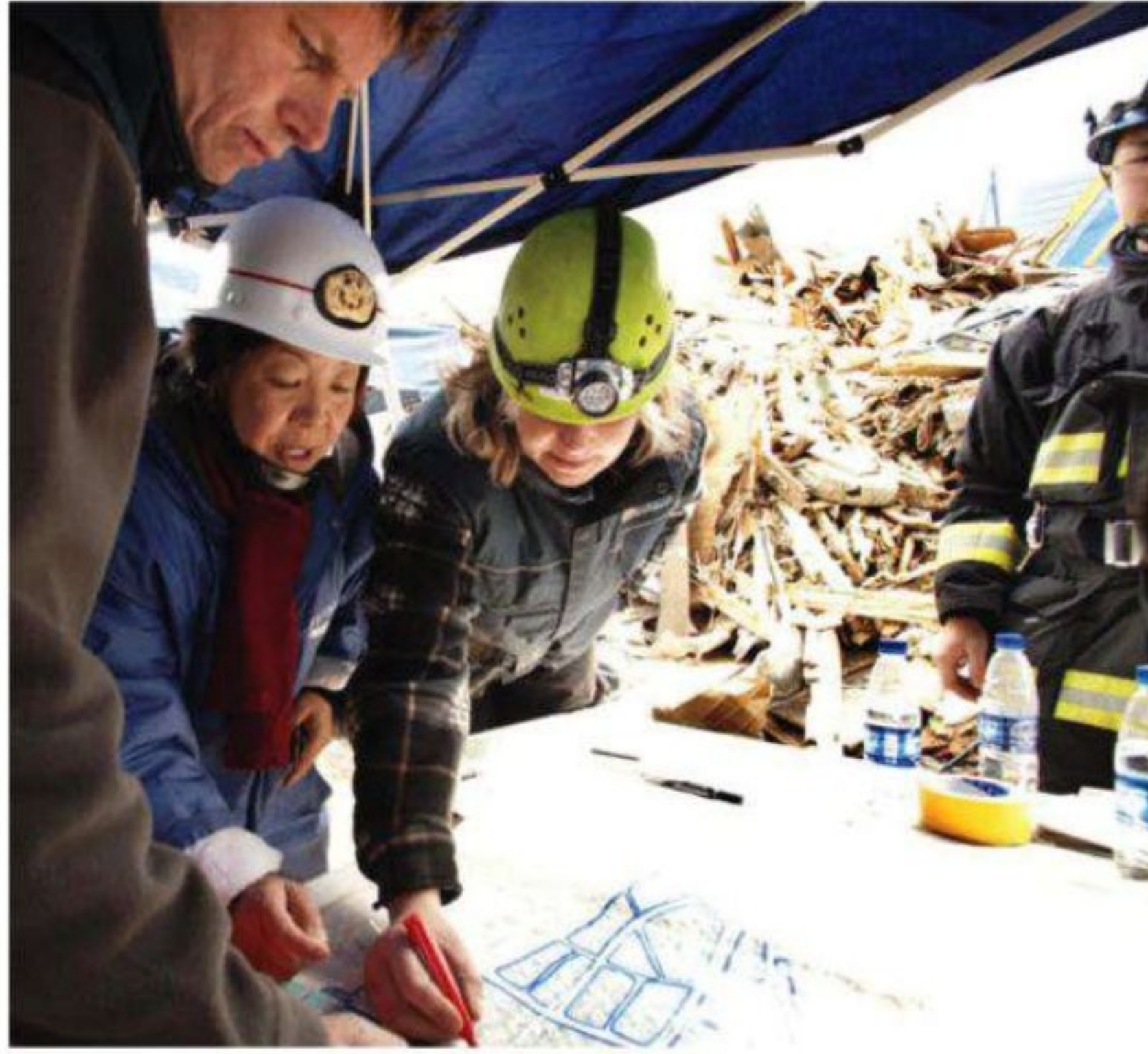
When the tsunami hit the continental shelf, the wave slowed but grew in

height. The surge topped seawalls, some nearly 40 feet high. Kesennuma, like almost every town along the coast, was quickly inundated.

Masako Tanaka learned at a young age to head to high ground after feeling an earthquake. Her home in the coastal city where she grew up, near Kesennuma, was flooded by a tsunami in 1960. But in an unfamiliar town, she wasn’t sure where to go.

“We were patiently driving downtown, but there were so many cars, we could only go inch by inch,” she says. “Then the alert system was warning us

MASAKO TANAKA BARELY SURVIVED THE 2011 TSUNAMI—THE SECOND SUCH CLOSE CALL OF HER LIFE. INSTEAD OF RETURNING HOME TO LOS ANGELES, SHE STAYED IN HER NATIVE JAPAN TO SERVE AS A GUIDE AND TRANSLATOR FOR RESCUERS.



to get out of the car and evacuate to the hills. But people do not think to listen. They just kept going in their cars."

Abandoning their car, they saw a Japanese Coast Guardsman dashing back to his post at the port. Tanaka had just asked him for directions when he saw a video on his cellphone screen. On it was a live feed of the port's entrance, already frothing with the tsunami surge.

Tanaka and her aunt followed the guardsman to a nearby apartment building. Water gushed into the stairwell as the trio raced up two flights of stairs. The water flooded the stairwell by the time they reached the top; Tanaka's aunt and the guardsman pulled her up to the roof from chest-high water. From there, the trio made a short leap to a neighboring four-story concrete building.

The survivors watched from the roof as water surged through the town. "I could tell that all of the people in cars were swept away by the time we were on the roof," Tanaka says. The incalculable tide overwhelmed wooden structures.

Houses that didn't instantly disintegrate floated off their foundations. Concrete structures fared better, but the water washed over the roofs of three-story buildings. Ships, cars and bits of building wreckage ground against one another in the filthy water, which consumed and absorbed anything in its path.

Japan is obsessed with tsunamis. High-water marks in Japan warn travelers how high previous tsunamis reached. And the government built a network of seawalls, costing billions of dollars, to protect the coasts. Yet a tsunami caused March's staggering death toll. What happened? "Japan never expected one this big," says Harry Yeh, an Oregon State University tsunami expert. The odds were in favor of the seawalls—there have been only seven quakes with a magnitude of 8.8 or higher in the 20th century.

But seawalls cannot be dismissed as

folly just because an abnormal event defeats them. In fact, Oregon State University researchers have found that small seawalls blunt the momentum of a tsunami even when overwhelmed. "In one of the lab trials, the seawall was physically ripped out of the ground, and the force was still reduced," says Mary Beth Oshnack, who studied the issue at OSU. "When you look at pictures from [post-2004-tsunami] Thailand, the walls are really damaged, but the buildings behind them have moderate damage."

The idea of building giant seawalls to guard the U.S. coast has been gaining traction. Texas governor Rick Perry supports them; last year the state formed a coalition of county judges to review a plan to extend a 17-foot-high, \$4 billion wall across Galveston Bay. Seattle is committing funds to a \$300 million seawall to replace one built in 1934. With hurricanes and tsunamis threatening national industries and large populations, these

CONTINUED ON PAGE 125

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Home

Your Table Is Ready

EXTRUDED ALUMINUM AND A MARBLE SLAB MAKE A COFFEE TABLE YOU CAN BUILD IN TWO HOURS OR LESS. BY ROY BERENDSOHN

➔ **I recently became aware** that we needed a new coffee table. Let me rephrase that. My wife made me aware that we needed a new coffee table. Those kinds of revelations happen when you're married. We'd bought a coffee table at a tag sale 20 years ago, and although it served us well, I have to admit that my wife was right. The table was beginning to look a little dated.

I drew up several designs for a replacement; I decided to forgo wood, opting instead to use extruded aluminum tubing for the base and a marble slab for the top. I was looking for a clean, mechanical, minimalist design. The base is made from fractional 15 Series smooth T-slotted aluminum, an extruded material with slots that accept connectors. You simply slide the



INSIDE

× MOWER MAINTENANCE + BUILD A SOLAR OVEN + CEILING FANS EXPLAINED

STUDIO D

PM DIY HOME /// COFFEE TABLE

legs, stretchers and connectors together and tighten the setscrews.

You can buy this aluminum in stock lengths and cut it to fit, as I did, but its manufacturer, 80/20, agreed to make parts available cut to the dimensions in our plans (8020.net; PM Coffee Table Base, Item Q-38819; \$188.56, plus shipping). The kit comes with precut legs and horizontal stretchers and the necessary connectors to join the parts. Using the kit, you can assemble the table base in about 15 minutes.

For the tabletop, I used a 1¼-inch-thick slab of Crema Marfil marble, an inherently durable and beautifully understated material. (Be sure to protect it with a granite and marble sealer.) Ordered from a local countertop fabricator, the top cost \$550.

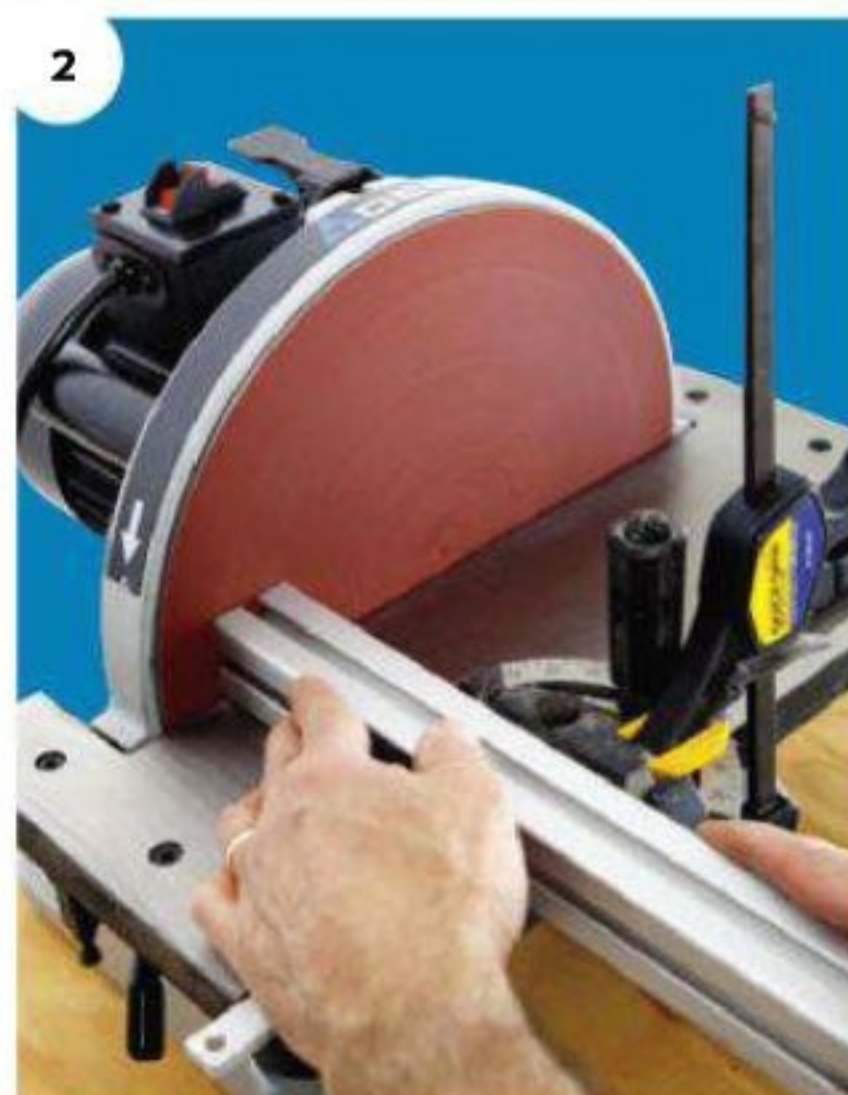
Our design is easy to build and hundreds of dollars less than similar tables. Better yet, it gives you complete control of the top's color and edge shape.

Make the Base

➔ **If you're cutting** the parts yourself, the extruded aluminum is easy to work with: Use an eight-teeth-per-inch metal-cutting blade in a jigsaw. Clamp a layout square to each leg or stretcher, and run the saw's shoe along its edge [1]. Cut each leg and stretcher slightly oversize and smooth each cut end, bringing the leg to finished dimension.

To do that, you can lightly press each cut surface against 80-grit abrasive paper on a disc sander [2]. Go easy. If you press too hard, you'll either tear the disc or remove too much metal. (Note that I held the sander's miter gauge in position with a clamp.) Lacking a disc sander, you can use a 10-inch-long double-cut aluminum file. Also called a Type A file, it has a relatively coarse, double-cut tooth pattern.

Use a combination square to position the right-angle connectors on the table legs. Set the square to 4½ inches and hold it against the bottom of the leg. Slip a connector into the leg's T-shaped slot, then slide the connector down until it hits the end of the square's steel rule. Tighten the setscrew with a



[1] Clamp an aluminum rafter square to each leg and stretcher to ensure the jigsaw makes a square cut. [2] We smoothed the cut end using a big Delta disc sander with its miter gauge clamped in position. Without a disc sander, you'll have to carefully file the cut end. [3] Set the blade on an adjustable combination square so that it forms a stop, butt the right-angle connector to the square, and tighten the connector's setscrews. [4] Thread a rubber foot onto the bottom of each leg. [5] Complete the leg-stretcher subassembly by sliding stretchers over the connectors and tightening the setscrews.

Popular Mechanics

WHEN CHANGING A LIGHTBULB JUST ISN'T ENOUGH



HEATING



HOT WATER



COOLING



LAWN AND GARDEN



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5/32-inch Allen wrench [3]. Thread a foot onto the bottom of each leg and tighten it with the Allen wrench [4].

Complete the base by assembling the legs, stretchers and mounting clips for the top. Slip a stretcher over the top of each leg, butt it tightly to the adjoining surface, and tighten the setscrews [5]. Complete the base by sliding the right-angle mounting clips into the groove.

Attach the Top

➔ **Rip and crosscut** the small plywood blocks that you'll use to mount the marble top to the base. Next, lay the top on a padded surface, mark the outside corners where each leg is to be positioned, and invert the base onto the top. Align the outside corner of each leg with its pencil marks. You can also invert the base onto the top and measure to get its correct location, then mark the outside corners of the legs on the top to provide the registration marks.

On a scrap piece of plywood, mix two-part epoxy and use a putty knife to spread it on the back of each plywood mounting block [6]. (You can wipe the knife clean using a rag dampened with mineral spirits.)

Press the block against the top and against the leg and weigh it down with a heavy object such as a brick.

After the epoxy has cured, slide down the right-angle mounting clip on each leg and butt it firmly to the plywood mounting block; tighten the setscrew [7]. Finally, secure each clip to the block using a 3/4-inch No. 12 pan-head sheet-metal screw driven through the hole in the mounting clip [8]. Note that these screws are not included in the kit.

With the aid of some helpers, carry the table upside down to where it needs to go. While holding the table above the floor, flip it over and set it down on its feet. Don't set the table on its edge and then flip it over. That might damage the top, the floor, the base or someone's foot. Finally, pull up a comfortable chair, have a beer, and relax. Yes, we know—it's a *coffee* table, but considering you built it, you're entitled.

PM



[6] Mix two-part epoxy and spread it on the plywood mounting blocks. Invert the blocks on the top and weigh them down while the epoxy cures. [7] Slide the right-angle clip down the leg and butt it against the plywood mounting block; tighten the setscrew. [8] Secure the table base to the top by driving a sheet-metal screw through the hole in the clip and into the block.



Build the PM coffee table with these plans and base components cut for PM readers from 80/20. Contact the company at 8020.net and order PM Coffee Table Base, Item Q-38819; \$188.56, plus shipping.

TAKE IT LIKE A MAN.



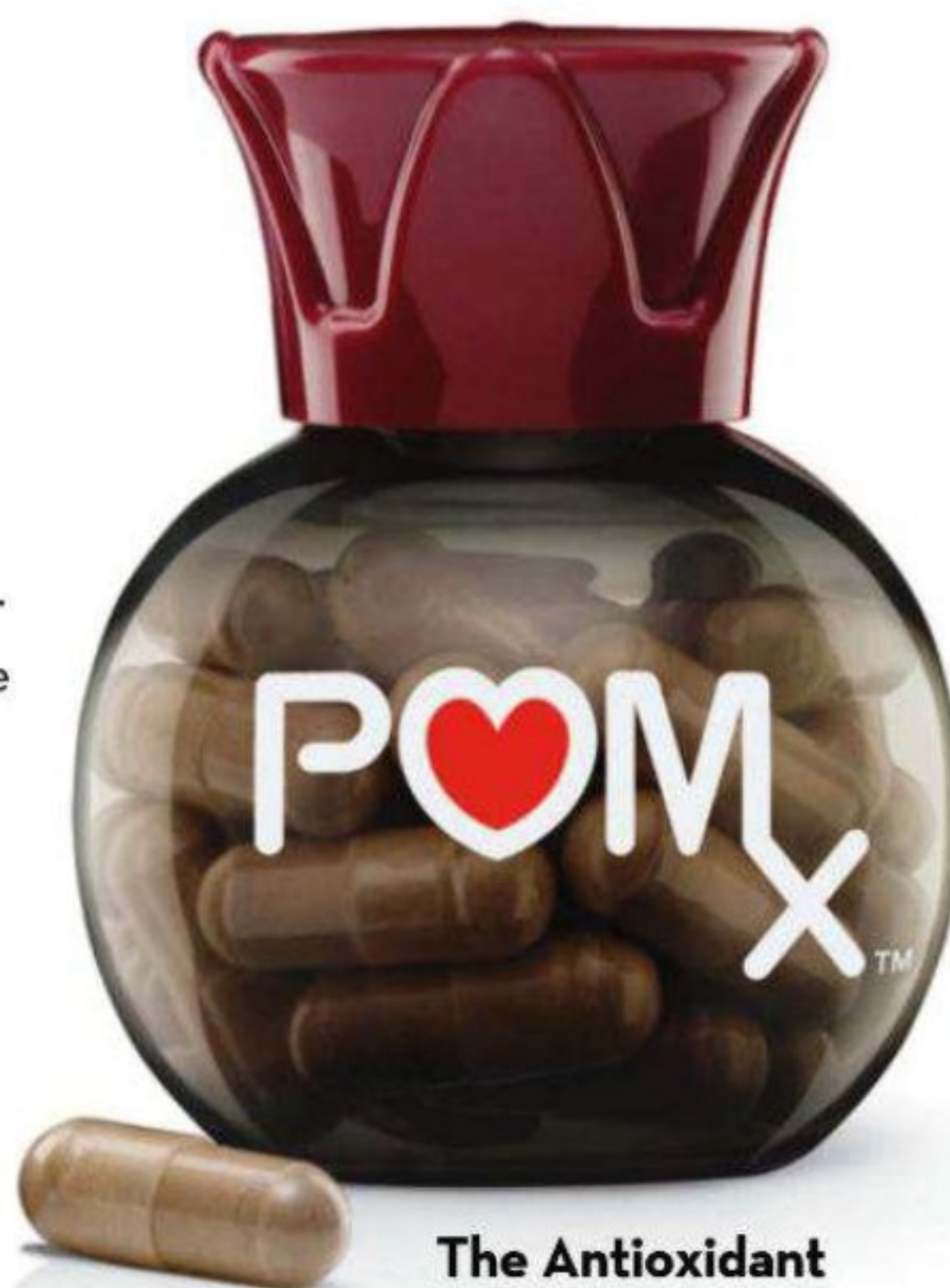
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Midsummer Mower Malaise

Every year about the middle of summer, my mower gets harder to start, and it doesn't run as strong as it did earlier in the season. I tune it up every spring, and it always runs on fresh fuel. How long can a mower go between tuneups?

A The tuneup interval for a typical small engine on a mower is about 50 hours or once a season, whichever comes first, but there are exceptions, according to manufacturers. "Machines used under heavy loads such as high ambient temperatures, dusty conditions or tall grass will require more frequent servicing," says Dennis Blair, technical service department manager for MTD, a manufacturer of lawnmowers and outdoor power equipment.

My guess is that your mower's malaise is being caused by the alcohol content of today's fuel blends. The alcohol in the fuel oxidizes to form a tenacious varnish inside the carburetor, which attracts moisture that causes corrosion. When it's not doing that, the alcohol stays busy damaging plastic fuel components (see

"Alcohol Awareness," *DIY Auto*, February 2011, page 93).

You mention you use fresh fuel, but I'd strongly recommend you do several things to improve your fuel supply and storage. First, use gasoline that has an octane rating no lower than 87, with an alcohol content no higher than 10 percent (E10). Next, a good rule of thumb is to buy only enough fuel to last two weeks. Take some fuel additive to the gas station and pour it into your fuel container before you fill up. You might also consider prepackaged fuel such as SEF Small Engine Fuel. Although expensive compared with fuel from the pump (\$5.50 to \$7.50 per quart), it's 94 octane and completely free of ethanol. It requires no additives.

Other problems can surface by midseason, especially in machines that have been worked hard. The air cleaner gets clogged with dirt; the blade dulls; and if you do your cutting in the early morning, when the grass is wet with dew, the underside of the mower deck gets plastered with a thick layer of grass clippings.

Here's a midseason checklist to cover your mower's service points.

1 Scrape the deck. Disconnect the spark plug and siphon out the fuel tank or remove it, then tip the mower back and give the deck a thorough scraping with a putty knife and a wire brush.

2 Sharpen the blade. Remove the blade and sharpen it with a mill bastard file. Take off an equal amount of metal from both sides—you can check by balancing the blade on a bolt clamped in a bench vise or by using a store-bought blade balancer. Employ a torque wrench when you reinstall the blade; tighten the blade-retaining bolt according to the specs in the owner's manual.

3 Check the plug. Install a new, properly gapped plug after 100 hours of operation or once a season, whichever comes first.

4 Service the air filter. According to engine manufacturer Briggs & Stratton, paper or foam filters should be replaced every 25 hours



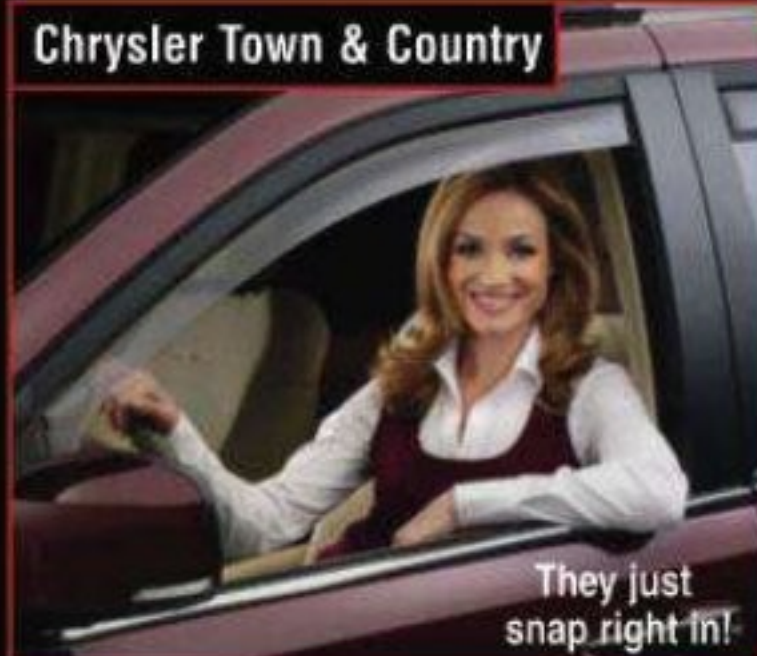
By midseason, a mower's air filter or prefilter can get pretty dirty. Check it and clean it if necessary.

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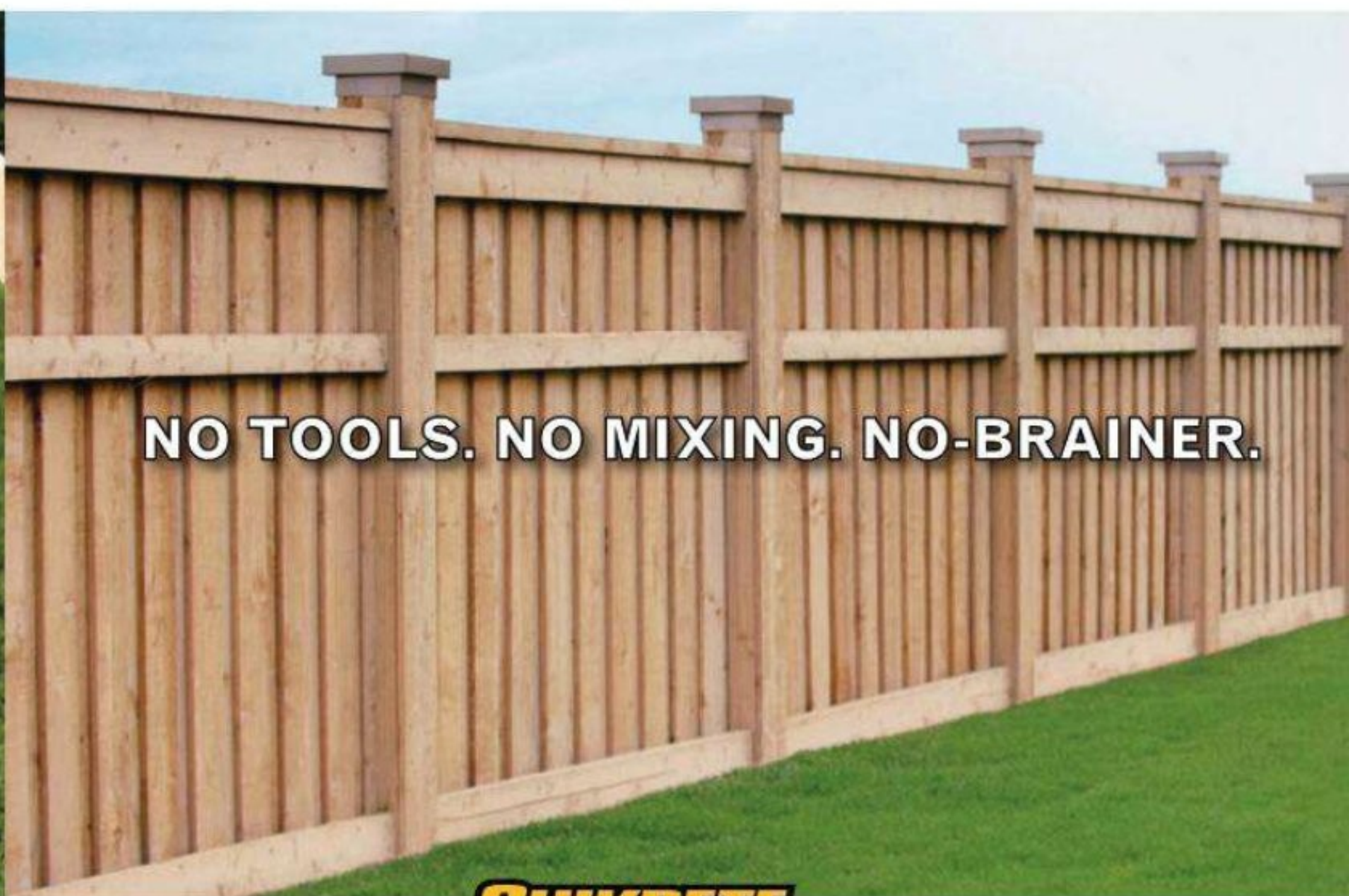
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of operation, while paper filters that have a foam filter pre-cleaner last for 100 hours of operation. Never use compressed air to blow out a paper air cleaner, because you run the risk of perforating the paper. "A teaspoon of dust that makes its way past a hole in the air filter can destroy an engine," according to Blair.

5 Clean the flywheel. If your mower sees more than 4 hours of use a week or runs in dusty and dirty conditions, uncover the flywheel at midseason and brush off the fins with an old paintbrush.

The Answer Is Blowin' in the Wind ➔

When it's gusty in the summer and most or all of the windows in the house are shut, the air pressure is strong enough to slam doors inside, especially a door that opens to the garage. I've seen it pull the doorknob out of your hand. This doesn't happen in a room with an open window, so we know it's not the wind pushing the door. Can we do anything to stop this?

Well, sort of. In most cases, this occurs in houses located where there is a strong prevailing wind. Negative pressure builds up on the downwind side of the house, sucking out air and creating a pressure drop inside. The problem is magnified by exhaust fans that pull more air out of the house. I've seen this phenomenon, and I have to admit that it's pretty amazing—and a little creepy.

Whether the garage door is open or closed can exaggerate or diminish the effect, depending on the wind direction. That door is the single largest opening in the house, and it can make a huge difference in the house's aerodynamics. Try raising or lowering the door to see if that has any effect. If the house doesn't have a garage door, experiment with opening windows to equalize pressure (assuming you're not running the air conditioning, that is). Also, have a look at some of the dampers sold by Tamarack Technologies. These can help you correct the troublesome pressure differential that's causing this ghostly door-slamming.

Monitoring the Meter ➔

Where I live in Texas, many of us have become alarmed that our electric bills have doubled or tripled since the utility company installed smart meters on our houses. Can we independently track our electrical consumption, then compare the information to our bills?

Yes, you can set up your own parallel electrical monitoring system, but it's expensive, and it's unlikely that you'll find that the utility meter is inaccurate. Most people who install these systems don't do so to check up on the utility; they do it to monitor their own electrical load in real time and take corrective action. The monitors cost anywhere from \$200 to \$800. In order to recover that investment, you have to put in the time to analyze the data these systems provide. If you lose interest after a couple of weeks, your investment in the system is wasted.

You're not alone in asking about the accuracy of smart utility meters, which continually sample energy use and report back to the utility. As these devices make their way onto the electrical grid, they eliminate crews of meter readers, and, when coupled with smart-grid technology, they help a utility manage the grid, cutting fuel use and operating costs. Smart meters are being introduced all across the country, often with changes in electrical rates and a resulting backlash from customers. The meters' introduction in California created such an uproar that Pacific Gas and Electric commissioned a consultant to examine the complaints. The 34-page report found that the meters were accurate, but the controversy continues.

Energy-use monitors don't take the place of a smart meter. Most are installed inside the home, usually with a current-measuring device wired into or connected to the house's service panel. Once installed, the monitors transmit data that you can read on a laptop or a smartphone. For example, the eMonitor by Powerhouse Dynamics can measure up to 100 circuits (at 120 or 240 volts), identify which circuits see the most energy use and perform subtle analyses such as recording phantom loads—the small current that many devices draw

Continued on page 104

The Breeze Machine

THE CEILING FAN IS THE KEY TO MOVING INDOOR AIR, KEEPING COOL AND MAXIMIZING AIR-CONDITIONER EFFICIENCY. WELCOME TO THE REVOLUTION. BY HARRY SAWYERS

➔ **Installing a ceiling fan is easy,** according to how-to videos and breezy online tutorials. But these instructions assume that an electrical box rated to hang 70 pounds of fan is just sitting in the ceiling, mounted to a joist on bolts strong enough for chin-ups. Sorry, but unless you're replacing an existing fan, that box isn't in place yet.

What is there, most likely, is a basic lighting fixture connected to someone else's electrical work—a pile of wiry pigtailed wires bearing a strong resemblance to a can of worms. Replacing it involves clearing out a wrist-size hole and then reaching back in to mount a metal box, clamp the wires and secure their connections, all while never once getting a clear look at what you're doing. Now, many amateurs can hang a pot rack or an overhead planter, and most can wire a receptacle, but few can do both at the same time. If the project gets unmanageable, a licensed electrician can finish the job for around \$175.

Once the box is in, the work really is easy, and a lifetime of cool breezes is within reach.



INSIDE

- ➔ INDUCTION MOTORS EXPLAINED
- ➔ BLADES ➔ WIRES ➔ DOWN RODS
- ➔ DUST BUSTERS ➔ RPM BONANZA



3 SOUNDS
OF FAN
FAILURE

SQUEAKING

→ A series of squeaks suggests a loose screw. Tighten fasteners connecting the canopy, the blades and the globe.

CLICKING

→ Clicking indicates a bearing gone bad. It happens. The bearing (or motor) may be replaceable. Ask the manufacturer.

WAH-WAH

→ It's over. This magnetic noise signals defective internal motor components, a problem in cheap fans. Replace the fan.

of operation, while paper filters that have a foam filter precleaner last for 100 hours of operation. Never use compressed air to blow out a paper air cleaner, because you run the risk of perforating the paper. "A teaspoon of dust that makes its way past a hole in the air filter can destroy an engine," according to Blair.

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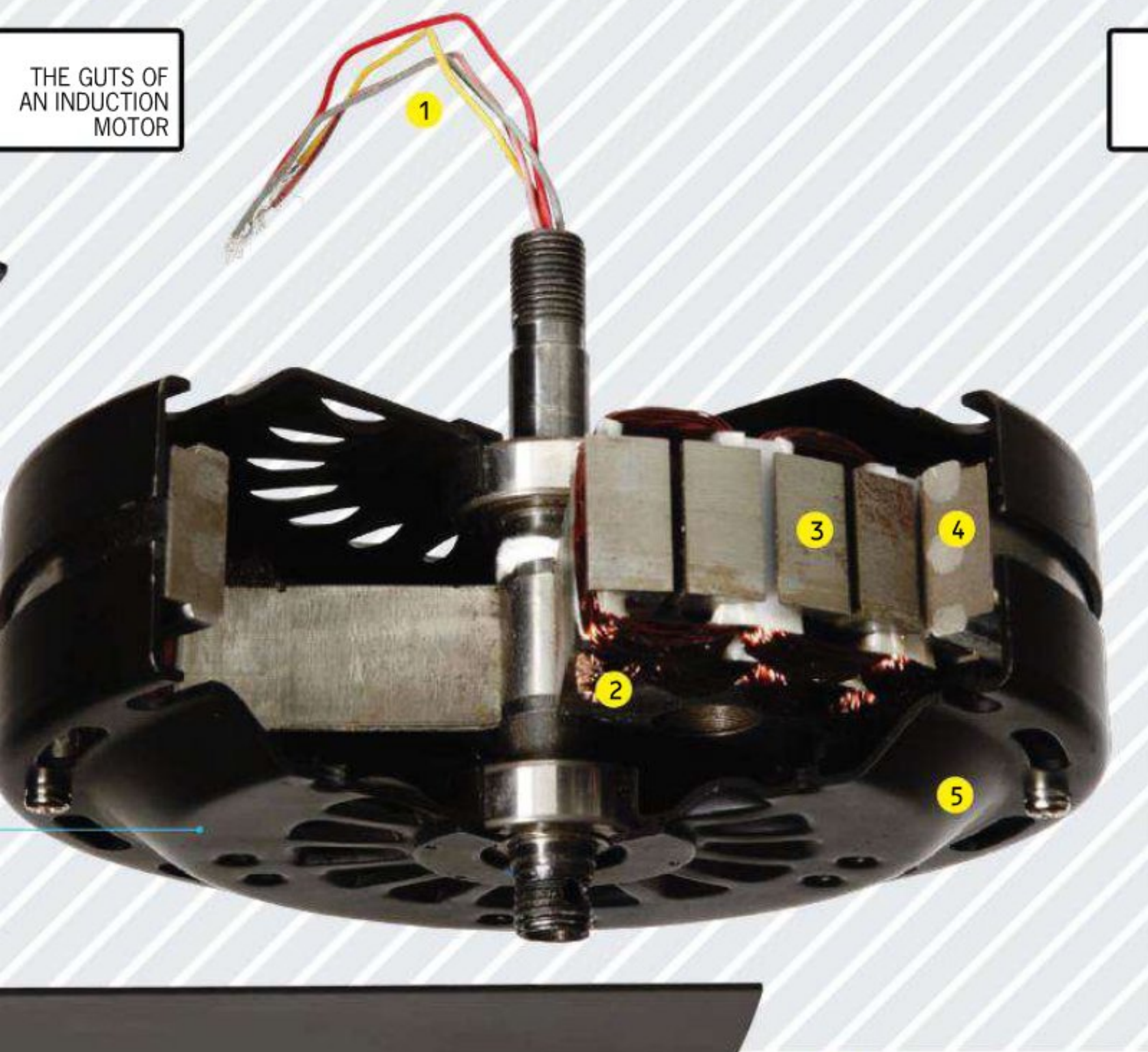


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THE GUTS OF AN INDUCTION MOTOR



BLADE GEOMETRY



BLADE TILT → Most blades tilt between 12 and 14 degrees off horizontal. Decorative blades, such as textured palm fronds, can tilt up to 20 degrees.

FAN RPM → Fans on low speed revolve 40 to 70 times per minute. Medium speeds range from 100 to 115, and high speeds hit 180 to 200.



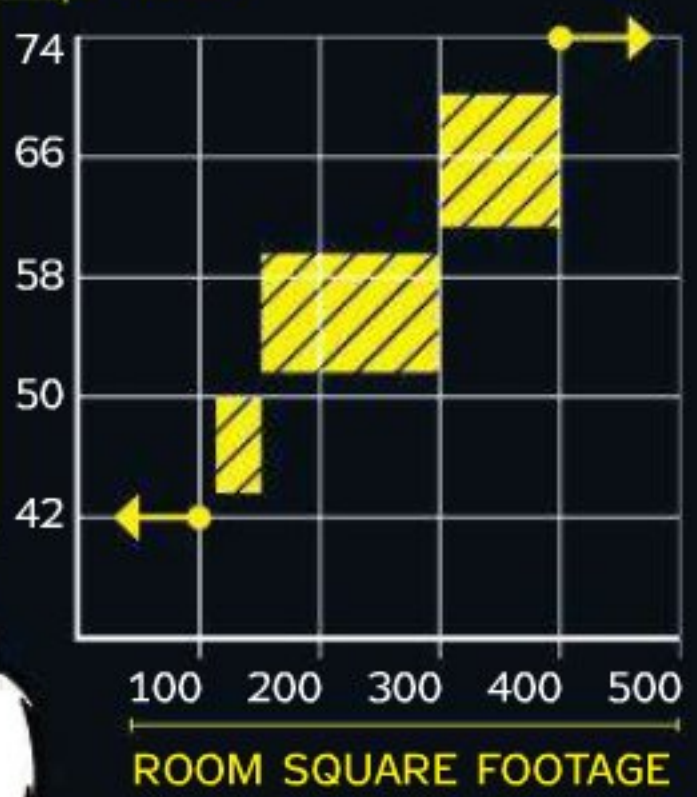
BLADE COUNT → A high blade count cannibalizes airflow per blade, according to manufacturer Fanimation's John Moody. "Looking strictly at what moves the air most efficiently, three blades are best," he says.



ROTATION RULE → Blades tilt so that a counterclockwise rotation pushes air downward to cool a room. Reverse the rotation, and blades draw air upward to circulate the hot air hugging the ceiling without creating a direct draft into the room. Here's the rule: Go clockwise in cold weather.

IDEAL BLADE LENGTH PER ROOM SIZE →

DIAMETER OF AREA SWEEPED BY BLADES, IN INCHES



Induction motors use a rotating magnetic field to move machinery. Nikola Tesla demonstrated the technology in such devices as 1893's Egg of Columbus. Early motors operated at a single speed; semiconductors made them more practical by enabling variable-speed operation.

1 WIRES Conductors carry electrical current to sets of copper coils called windings.

2 WINDINGS Wrapped around steel bars, or laminations, energized windings form an electromagnet called a stator.

3 STATOR Fluctuating polarity creates a rotating magnetic field in the stator. The field crosses a 0.3-mm gap to induce a current in laminations in the rotor, which spins around the stationary stator.

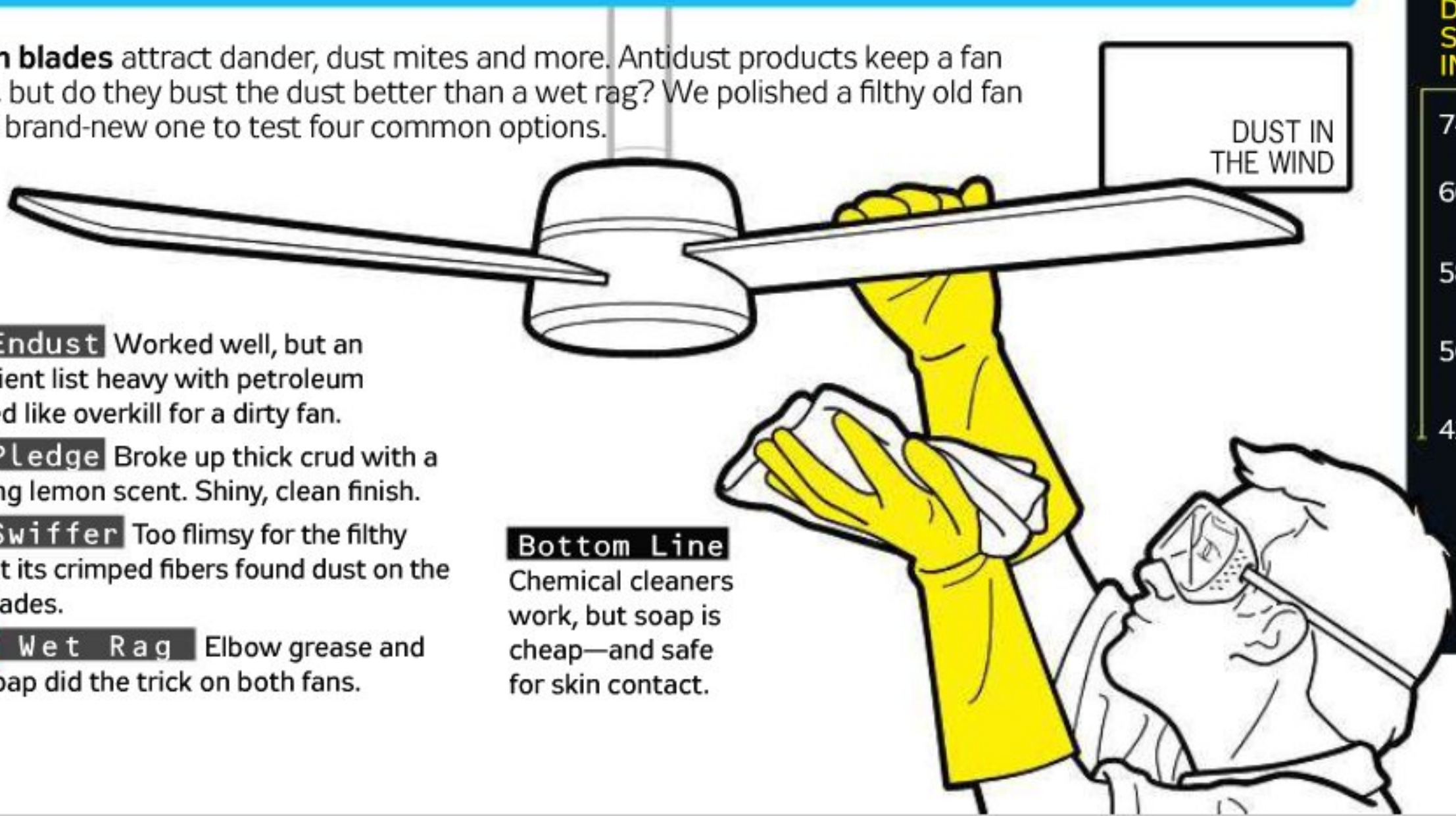
4 ROTOR The angle at which the stator faces the rotor, the physical distance between the two, and the geometry of slots carved into each set of laminations combine to create two out-of-phase magnetic fields. The rotor spins because it repels the rotating magnetic field induced by the stator.

5 HOUSING The motor housing envelops the rotor as it revolves on bearings around the stator. In the design shown here, known as an inside-out motor, fan blades attach to the housing bottom. Vents on top cool the motor—it needs a breeze, too.

Fan blades attract dander, dust mites and more. Antidust products keep a fan clean, but do they bust the dust better than a wet rag? We polished a filthy old fan and a brand-new one to test four common options.

- 1 Endust** Worked well, but an ingredient list heavy with petroleum seemed like overkill for a dirty fan.
- 2 Pledge** Broke up thick crud with a pleasing lemon scent. Shiny, clean finish.
- 3 Swiffer** Too flimsy for the filthy fan, but its crimped fibers found dust on the new blades.
- 4 Wet Rag** Elbow grease and dish soap did the trick on both fans.

Bottom Line Chemical cleaners work, but soap is cheap—and safe for skin contact.



PM DIY HOME ///
HOMEOWNERS CLINIC Q + A

even when they are switched off.

If your electrical use is modest compared to your consumption of heating fuel (for instance, if you live in a cold climate, don't have electric heaters and spend little on air conditioning), you probably won't make your money back on one of these monitoring systems. Instead, you can make direct gains by replacing an outdated refrigerator, installing light dimmers, wiring in a setback thermostat and adding insulation to the attic or basement walls. In fact, those are all good steps to take regardless of where you live.

Sniffing for CO ➔ The instructions for my CO detectors show the device plugged into a wall outlet while a battery-powered unit is mounted up on the wall. Given that CO is slightly lighter than air, where is the best mounting location?

Carbon monoxide is, indeed, a bit lighter than air—the gas easily mixes with air and travels throughout the house quickly. While that makes CO dangerous, it also means it will soon come within range of a correctly placed detector. Unless the manufacturer states otherwise, the device can be plugged into a wall outlet or mounted on a wall or ceiling like a smoke detector. Some municipalities require CO detectors in or near bedrooms when the home contains a fuel-burning heating appliance. The town may require that the detector not be closer than 20 feet from a fuel-burning boiler or furnace, to avoid false readings (heating equipment sometimes makes a tiny amount of CO on startup).

Keep CO detectors at least 10 feet from bathrooms, where they can be affected by high humidity, and avoid locations with airborne dust (such as wood shops) or grease (the kitchen). Don't install these devices where there is so much air movement that they may miss the CO—next to a window that is frequently opened, by a ceiling fan or an air-conditioner vent. Conversely, don't place one in a dead-air space, such as where a wall meets the ceiling or at the peak of a vaulted ceiling.



PROBLEM SOLVED

HANDLING THE AIR HANDLER

➔ Anybody who has opened an air handler on a sweaty summer afternoon to replace an air filter or clean the A-frame coil can tell you how dark, dirty and crowded those cabinets can be—complete with ratty-looking insulation.

Trane's Hyperion Air Handler solves these problems. Its double-wall, gasket-protected cabinet is airtight, and the insulation is between its walls, as in a refrigerator. These features protect the insulation, improve energy efficiency and eliminate

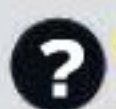
dust infiltration—especially important when the air handler is placed in the attic. Also, the double-wall design provides a pocket for the control board, protecting it from humidity inside the cabinet. The inverted aluminum A-frame is about as accessible for cleaning as an evaporator coil can be.

The Hyperion's cost depends on the air-conditioning system that is installed with it. Expect prices from \$4000 to \$15,000; the high end of the range is for ultra-high-efficiency systems.



Drain Pain ➔ When we had our master shower redone a couple of years ago, the contractor cut the concrete floor and installed a flexible Fernco fitting on the rusty cast-iron drain. Now we have a leak that shows up as damp baseboard trim in the guest bathroom on the other side of the wall. Could the leak be at the fitting?

Maybe, but I doubt it. That would mean that the soil around the leak is saturated and the moisture is moving up through a crack in the concrete. Then the baseboard would have to wick it up. Besides that, plumbers are typically meticulous with these connections, because the last thing they want is to come back and recut a concrete floor—there goes the job's profit. "I'd lean more toward a leak in the supply to the shower valve or a leak at the valve itself," Pat Porzio, a Clinic contributor and a master plumber, says. Although these days he's HVAC manager for Russo Brothers in East Hanover, N.J., Porzio has done his share of general plumbing. "A sneaky way to check for a leak like this is to remove the baseboard and the drywall trim immediately behind it," he advises. "See if you can spot water coming from above while the shower is running." Fix the leak, then replace the drywall and trim. **PM**



Got a home-maintenance or repair problem? Ask **Roy** about it. Send your questions to pmhomeclinic@hearst.com or to Homeowners Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.

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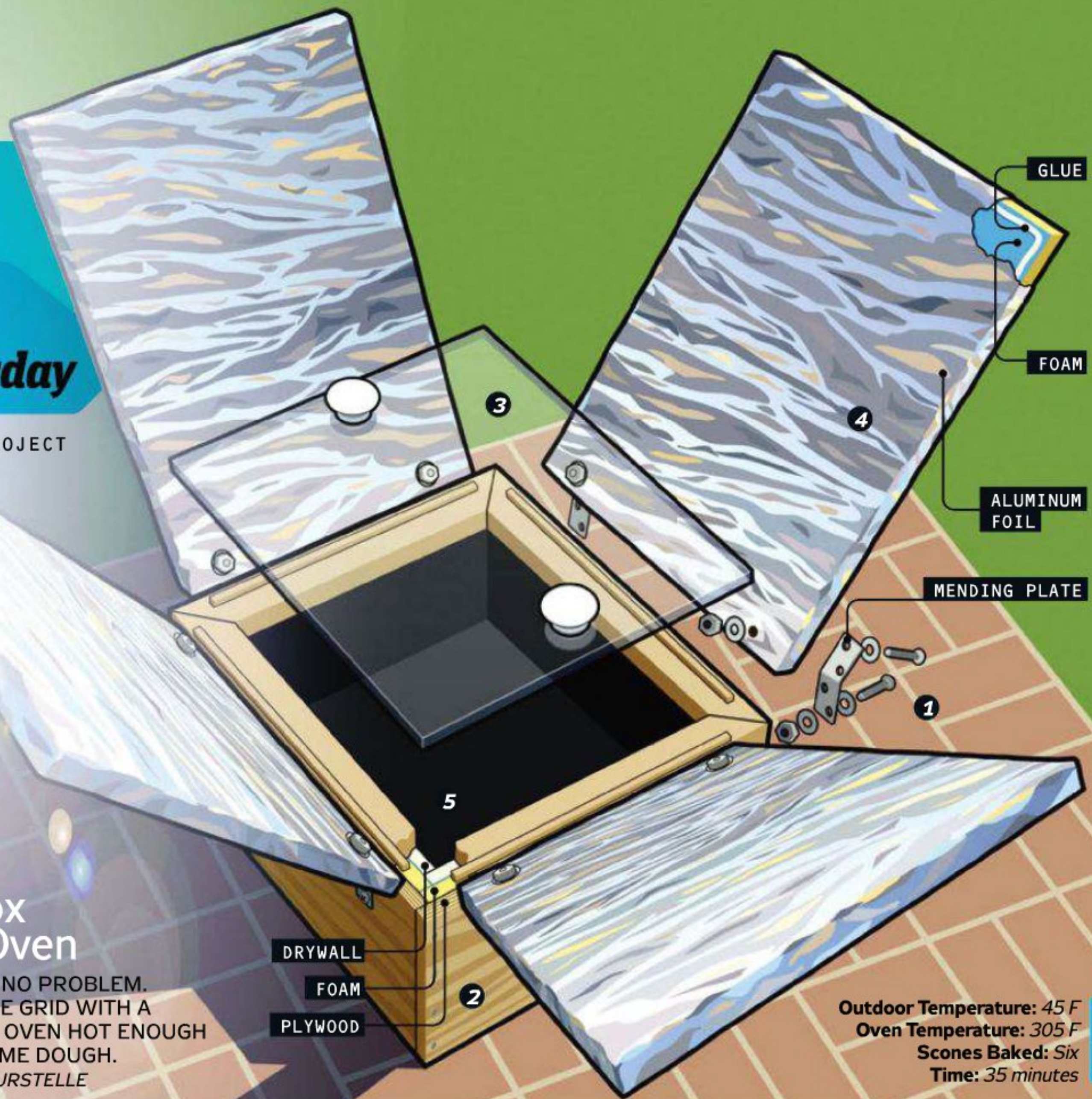
PM Saturday

ONE-DAY PROJECT

Hot-Box Solar Oven

NO POWER? NO PROBLEM. BAKE OFF THE GRID WITH A SUN-FUELED OVEN HOT ENOUGH TO RAISE SOME DOUGH.

BY WILLIAM GURSTELLE



Outdoor Temperature: 45 F
Oven Temperature: 305 F
Scones Baked: Six
Time: 35 minutes

1 → FIND PARTS This March in Minnesota, our solar oven got hot enough to bake a killer batch of scones—and in the summer, it can whip up brownies in a brownout. The project makes use of scraps (or full 4 x 8 sheets) of $\frac{3}{4}$ -inch and $\frac{1}{2}$ -inch plywood. It also requires 4d trim nails, a 6-foot length of $1\frac{1}{2}$ -inch-wide flat wood trim, 36 inches of $\frac{1}{4}$ -inch-square molding, a half-sheet of $\frac{1}{2}$ -inch rigid foam insulation, a half-sheet of $\frac{1}{2}$ -inch drywall, two white ceramic knobs, eight 3-inch mending plates, construction adhesive, high-temperature flat black spray paint, heavy-duty aluminum foil, No. 8 bolts, washers and nuts and a piece of $\frac{1}{4}$ -inch plate glass cut to 13 x 14½ inches, with the edges sanded smooth.

2 → BUILD THE BOX Construct an open-top box using $\frac{3}{4}$ -inch plywood for a 14 x 15½-inch bottom. Use $\frac{1}{2}$ -inch plywood to make four 7-inch-tall sides. With a vise and pliers, bend the mending plates to 135-degree angles. Fasten two plates to each box side with 1-inch No. 8 bolts, washers and nuts. Cut pieces of rigid foam insulation to line the box interior. Glue the foam to the plywood using construction adhesive. Cut and glue drywall panels to fit on top of the foam. Paint the interior black.

3 → PREP THE TOP Nail wood trim over the edges of the foam and drywall. Cut the molding into four 9-inch lengths. Center the glass pane over the opening. Put the moldings

around the glass perimeter. Nail them down to steady the pane. Glue the knobs to the glass.

4 → MAKE REFLECTORS Cut rigid foam to four 12 x 24-inch panels. Wrap the foam in aluminum foil. Bolt the panels to the plates.

5 → BAKE IT UP Prep food in a black enamel pot with a lid; set the pot in the box. Replace the glass. Prop up the oven at an angle so the sun and reflectors shine directly on it. Use an oven thermometer to gauge heat. Note: This oven does not bake as quickly as a regular one (but our scones, with butter and lingonberry jam, were still delicious). Wear oven mitts to handle the ceramic knobs—they get hot!

+ MORE TO DO IN JULY

Build on the Beach

→ Race milk-carton boats and craft elaborate sand castles on the shore of Minneapolis's Lake Calhoun at the 72nd annual Aquatennial. Bring your best boatswain gear. Judges award points for creativity. July 15 to 23.

Rein In the Rain

→ Phoenix gardener Vynnie McDaniels collects 60 to 80 gallons during summer storms. (*Bacillus thuringiensis* pellets in the bins control mosquitoes.) "It's all about directing the water where you want it to go," he says.

Score a Crankshaft

→ Find propellers, intake manifolds and crankcases for classic Evinrude and Mercury outboard motors at Tomahawk Nationals, the 32nd annual meeting of the Antique Outboard Motor Club's Northwoods chapter. July 27 to 30.

Be Bear-Aware

→ Avoid a mama-grizzly mauling by following good backwoods bear practice: Tread loudly on the trail, back away from bears on the prowl and, if you get desperate, play dead, Glacier National Park's Amy Vanderbilt says.

Keep the Cool Air In

→ Optimize window a/c efficiency by replacing the expandable gap sealers with cut-to-fit panels of foam insulation caulked at the seams. Keep the air filter clean, and close the curtains on windows that get intense sunlight.

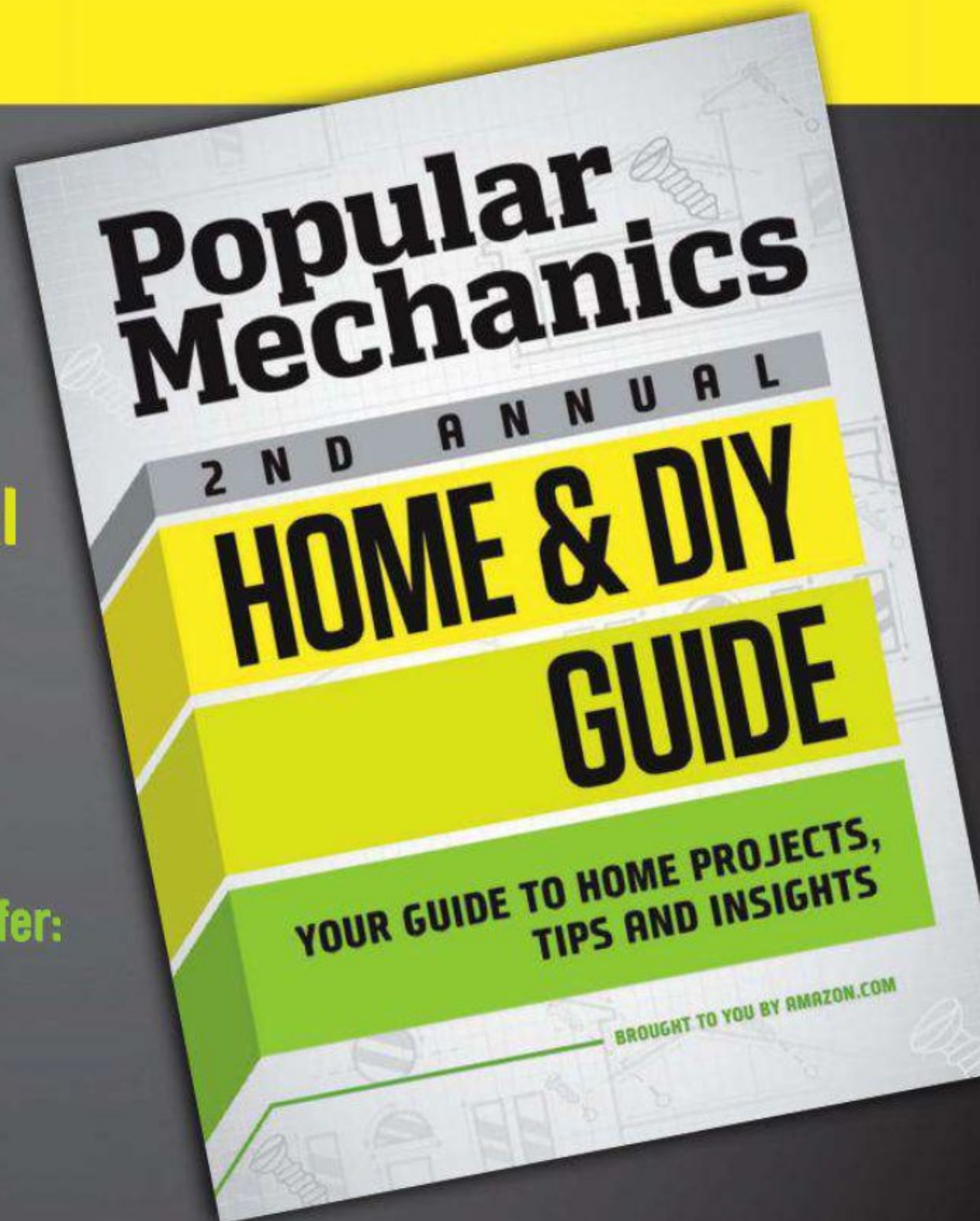
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WE TEST GAS-SAVING DRIVING TACTICS. BY MIKE ALLEN

➔ **Gas is expensive.** In fact, it's close to historic highs, and drivers are trying to find ways to conserve fuel—and protect their wallets. Fortunately, there are ways to save that don't involve buying a hybrid car, or sitting at home. Recent POPULAR MECHANICS testing proves what many have argued: that modifying how you drive can boost fuel economy. But not all of the conventional advice is right. To separate efficiency truths from myths, we outfitted an ordinary set of wheels (a 2001 Suzuki Grand Vitara; odometer reading 110,000 miles) with a precise fuel-economy sensor, then started driving. The conclusion: If a formerly lead-footed driver employs the tactics presented here, he could save up to 10 percent—that's hundreds of bucks a year. So ease off the pedal, and let's dive into the data.

TACTIC NO. 1
Coast to a Stop

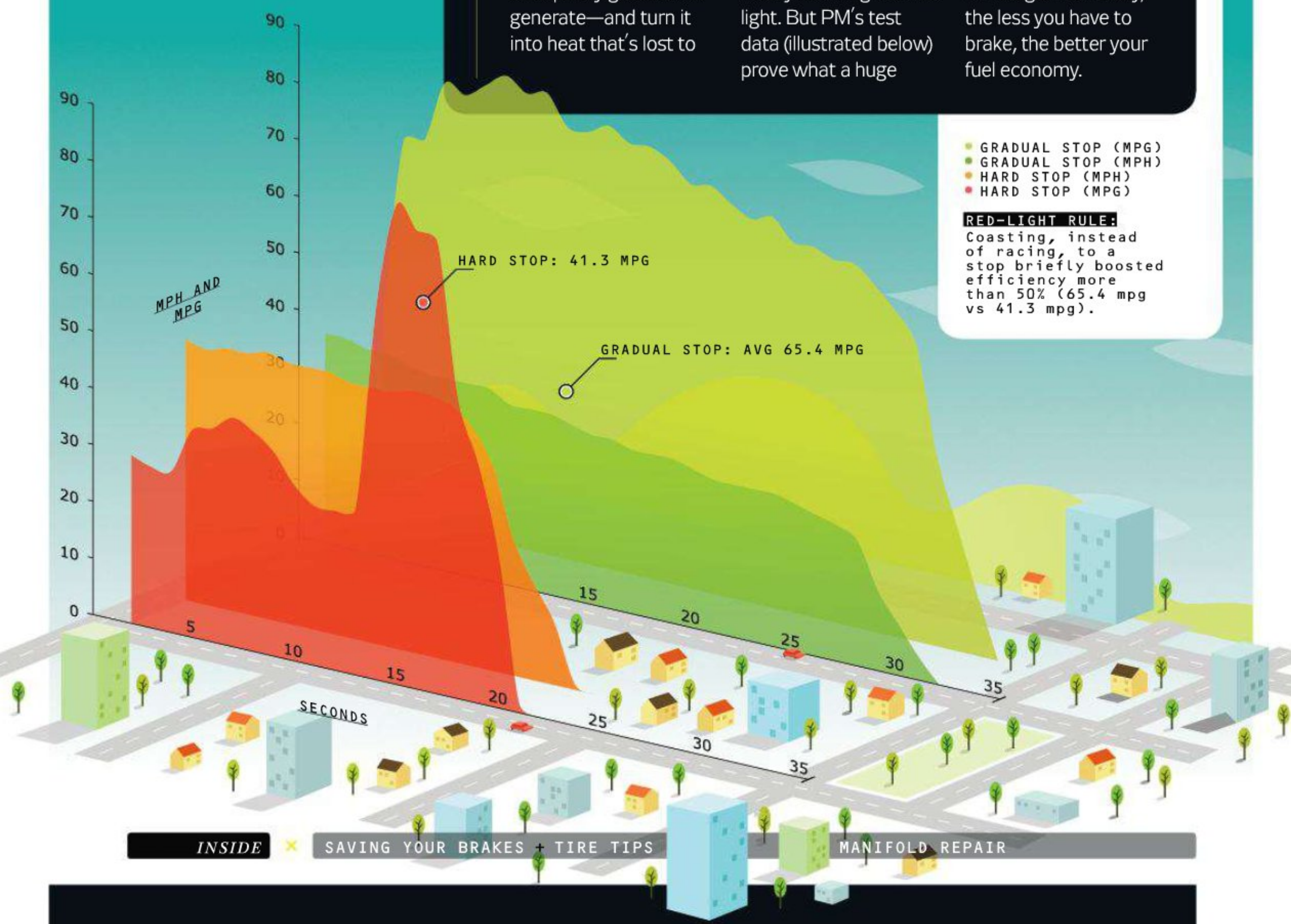
Brakes are necessary (duh!), but they're inherently wasteful: They take the kinetic energy of a moving car—energy it took pricey gasoline to generate—and turn it into heat that's lost to

the air. Everyone knows that accelerating until the last moment then braking hard to stop is less efficient than slowly coasting to a red light. But PM's test data (illustrated below) prove what a huge

difference coasting makes. The lesson: Whenever possible, anticipate that a light will turn red and ease off the gas. Generally, the less you have to brake, the better your fuel economy.

● GRADUAL STOP (MPG)
● GRADUAL STOP (MPH)
● HARD STOP (MPH)
● HARD STOP (MPG)

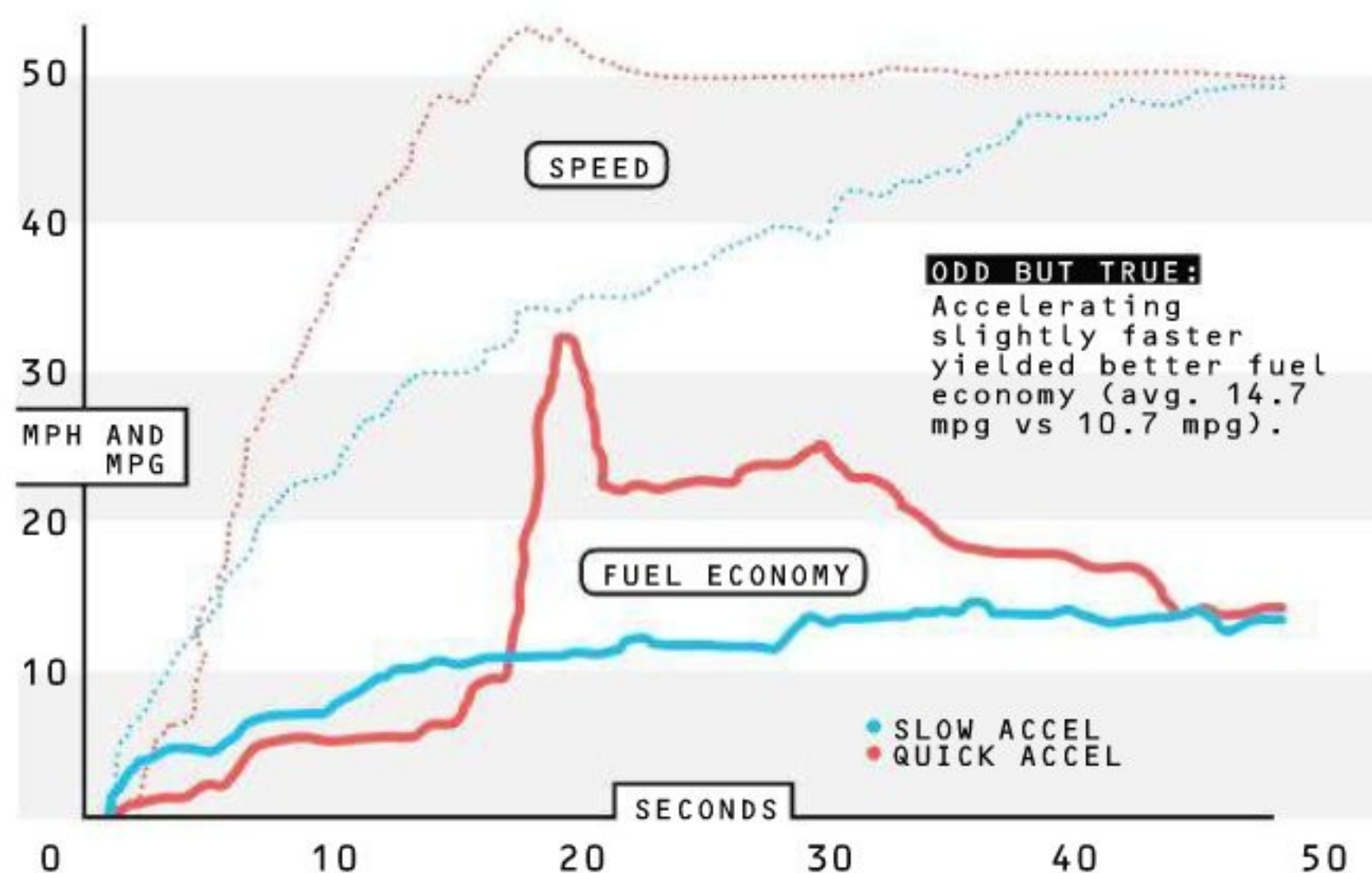
RED-LIGHT RULE:
Coasting, instead of racing, to a stop briefly boosted efficiency more than 50% (65.4 mpg vs 41.3 mpg).



TACTIC NO. 2

Close Windows
and Use a/c at
High Speeds

It's a fierce efficiency debate: Open the windows in summer to avoid running your energy-intensive air conditioner, or keep the windows closed and the a/c on to preserve your car's aerodynamic profile. (We'll leave aside the option of sweating it out.) PM's testing settled the issue. Driving at 55 mph with the a/c running, we got 24 mpg; turning it off bumped us up to 28 mpg. Then we opened all four windows, one at a time, and lost 1 mpg per window until we were back at 24 mpg. So at that speed, it's a wash. But aerodynamic drag rises exponentially with speed—the faster you go, the more the open windows hurt efficiency. The answer? Below 55 mph, open the windows and leave the a/c off. But at 60 mph or higher, keeping them closed and the air conditioning running will burn less fuel.

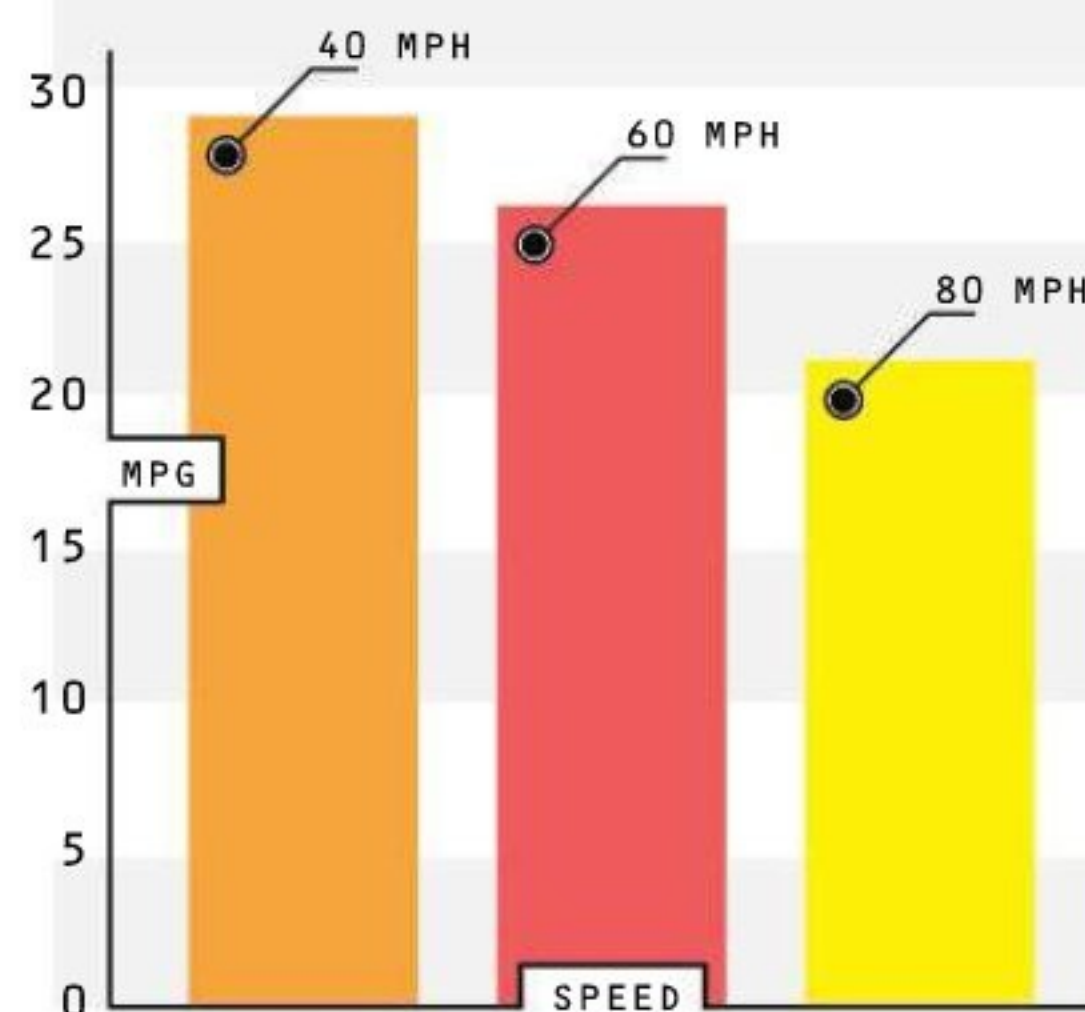


TACTIC NO. 3

Avoid Slowly
Crawling Up
to Speed

Conventional wisdom says that jackrabbit starts consume more fuel. But it turns out that nursing your speed up to the limit too slowly also lowers mpg. How can that be? Cars get poorer fuel economy in lower gears, and accelerating too slowly prevents upshifting at an efficient rate. The best acceleration rate varies with the vehicle, gear ratios and weight. But in our testing we found that taking 15 seconds to accelerate to 50 mph used less fuel than taking 30 seconds to reach the same speed, because the car entered its top, fuel-saving gear sooner.

TACTIC NO. 4

Cruise at a
Slower Speed

Since the power required to overcome aerodynamic drag is a function of the velocity cubed (in other words, it shoots up quickly), a car's jump from 40 to 60 mph requires less fuel than the increase from 60 to 80 mph. (As the graph above shows, the hit to fuel efficiency is roughly twice as severe in the higher range.) So go slower, right? Well, yeah, but fuel efficiency isn't the only thing that matters. Some studies suggest that the old 55-mph limit saved fuel but cost us more in terms of lost work hours. Then there's safety: Going 55 mph when traffic is cruising at 70 can be dangerous to everyone. Just don't go 80. That will drain your tank quickly—and the costs add up if you also have to pay for a speeding ticket.

FUEL-SIPPING BASICS

Monitor Tire Pressure

➔ Keep your tires properly inflated, because low pressure increases rolling resistance. Few drivers check and adjust their tire pressure often, but it's a good idea to do it once a week.

Plan Errands Carefully

➔ Reduce the miles you drive by running all your errands in one trip. Making a run to the dry cleaner and then picking up the kids after soccer practice? Don't make separate outings. A little bit of foresight will stretch your fuel economy.

Warm Up the Engine

➔ Cars get better fuel economy when the engine is warm. So if you have a three-stop run, hit the farthest destination first, then work your way back home. A fully warmed-up engine will remain at an efficient temperature even if it's parked for 30 minutes.

Make Right Turns Only

➔ FedEx does it, and the MythBusters proved it works: When city driving, make as many right turns as possible, even if it means going a few hundred yards out of the way. Reducing loiter time—or idling while waiting for traffic to clear—saves gas.

Avoid Ethanol When Possible

➔ Gasoline that has been cut with 10 or 15 percent ethanol, called E10 or E15, is an mpg killer. Why? Gasoline stores more energy than ethanol (119,000 Btu per gallon vs 80,000). So it takes more ethanol than gasoline to go the same distance.

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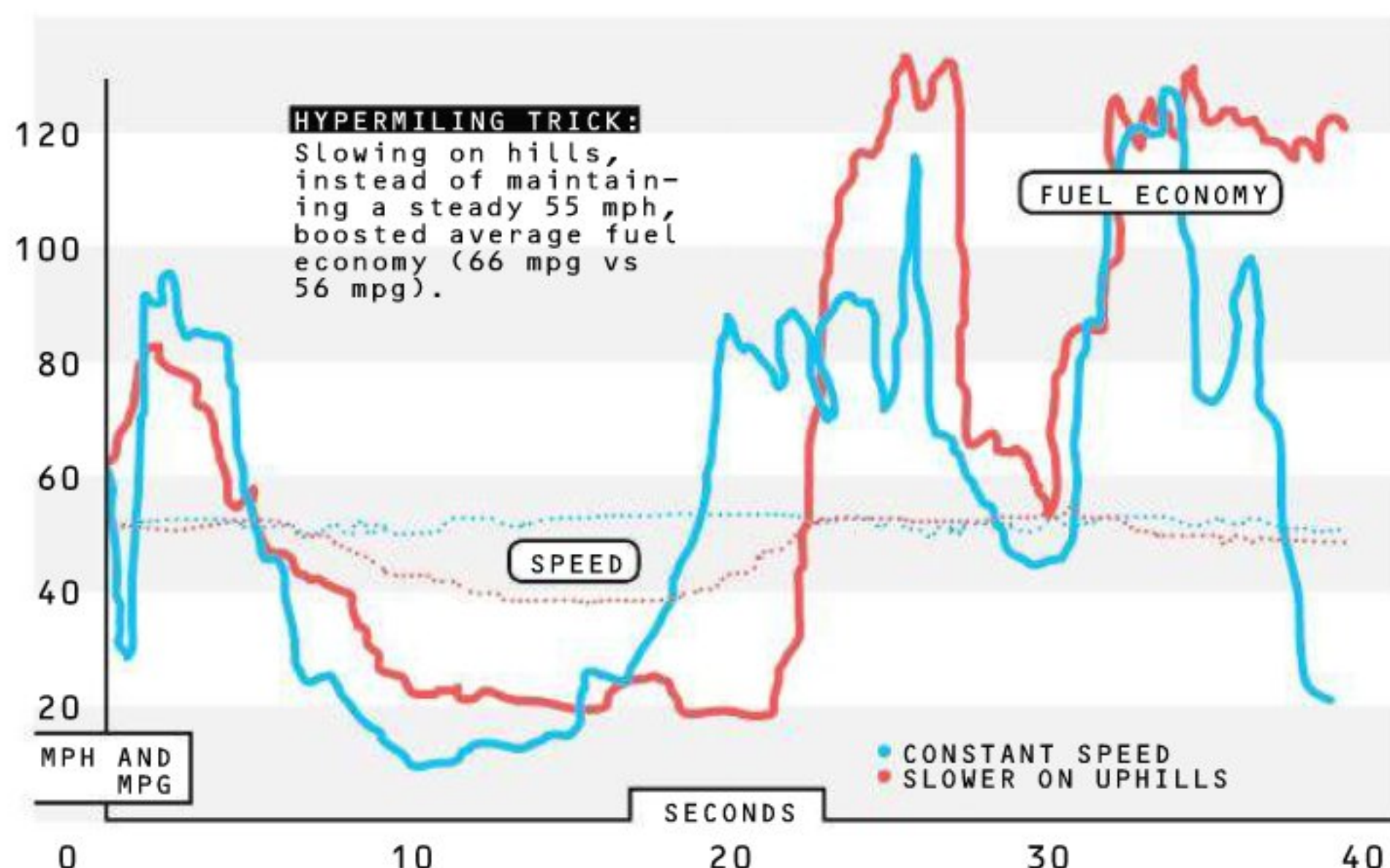
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TACTIC NO. 5

Climb Slowly (When It's Safe)

Imagine driving on a flat highway and approaching an overpass. From a fuel-efficiency standpoint, the best strategy is to turn off cruise control and forget about maintaining a constant speed up and down both sides of the grade. The theory predicts that, and our data prove it. The physics work like this: Lifting off the accelerator while traveling up the hill and allowing your speed to decay trades some kinetic energy (related to speed) for potential energy (related to the car's tendency to roll downhill). You regain the kinetic energy—and get better gas mileage—on the backside. While hypermilers—who are obsessed with getting the best possible gas mileage—claim significant economy benefits from this technique, our results showed only modest gains. Two things did happen, though: (1) We drew the wrath of a lot of drivers following us, as evidenced by their single-finger salutes; (2) We were nearly sideswiped by an impatient 18-wheeler. Yes, the method does work. But we'll save it for lightly traveled roads.

POPMECH TEST TOOLS

To develop the best tactics for fuel-efficient driving, we instrumented our car, then hit the road. To settle the long-standing question of whether it's better to coast along in neutral or in gear, we tapped into the fuel injection harness on the engine, hooking up to an oscilloscope to capture the opening and closing of the injector. For most of the other tests, we used Palmer Performance Engineering's DashCommand and ScanXL Pro software running on a generic Windows netbook computer, with Palmer's cable plugged into the OBD-II port under the dash.



TACTIC NO. 6

When Coasting Downhill, Leave the Car in Gear

There are those who refuse to be shaken from the practice of coasting downhill in neutral to save gas. This is a bad idea no matter how you look at it. Let's set aside fuel economy for a moment. Coasting downhill in neutral is illegal in most states. And it's dangerous in all states. In neutral, you have no way to accelerate to avoid a hazard, and if the engine stalls, you have no power steering or vacuum boost for the brakes. If the hill is steep enough to call for hitting the brakes to keep you from gaining speed, they're more likely to overheat—and overheated brakes lose effectiveness until they cool off. They'll probably do that right around the time the police show up to take the accident report.

Here's the surprise: There's no tradeoff between safety and fuel economy in this case. Leaving the car in gear while coasting downhill actually is more efficient. Why?

Most fuel-injected engines today use computer-controlled Deceleration Fuel Cut Off: When you lift your foot from the gas while leaving the car in gear, injectors shut off automatically, and the car's rotating tires—which are connected to the engine via the transmission—keep the engine turning and the accessories running. So, the engine consumes no fuel at all while the vehicle is coasting downhill.

In contrast, the fuel-consumption rate for an engine idling in neutral falls between 0.2 and 0.4 gallons per hour (gph). Splitting the difference and using 0.3 gph for our example, idling in neutral down a ½-mile-long hill consumes fuel for 30 seconds, for a total of about 0.32 ounces of gas. Popping the car into neutral actually wastes gas.

This may seem counterintuitive, but that's what data are for—replacing good guesses with solid facts. Watch the data, and over time the savings will take care of itself. **PM**

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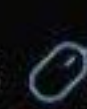
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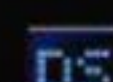


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Car Clinic

by Mike Allen

Q+A

This battery maintainer will take a very long time to recharge this deep-cycle battery, but will keep it at peak state of charge without killing it.

brilliant, because that strategy proportionally reduces overcharging and the rate of evaporation.

Modern maintenance-free batteries have no filler caps—and thus no way to add water, so it's vitally important to avoid overcharging. And AGM-class batteries are even more advanced. AGM stands for Absorbed Glass Mat: The sulfuric acid electrolyte is soaked into a porous fiberglass mat, and additional chemistry inside the battery recombines the hydrogen and oxygen back into water, making these truly maintenance-free devices.

Until you overcharge one with a constant-voltage trickle charger, of course. Your first step is to give that old trickle charger to someone you don't like and get a modern battery maintainer. These devices generally have three or more charging phases and are designed to be used full time. They start by assessing the battery's charge state, then charge at a constant voltage (like your trickle charger) up to 80 percent of the battery's capacity and finally taper off to slightly above the nominal 12.6 volts to avoid overcharging. Periodically the smart charger checks the battery's state of charge and briefly ramps up the voltage to replace any energy lost during the battery's normal self-discharge. Some even include a desulfation mode to break up any lead sulfate crystals growing on the plates, another problem caused by normal use and exacerbated by chronic undercharging.

I have probably a dozen battery chargers and maintainers lying around the shop, ranging in cost from \$15 to nearly a hundred dollars. Assuming your motorhome's battery is fully charged by the engine alternator when you park it, the smallest ones (around 1 amp) should do the job. Some larger chargers that have a maintainer function and are rated at 6 or 10 amps will actually recharge a decent-size battery from dead overnight—without cooking the water out. They're great for things like trolling-motor batteries that need regular recharging. Maybe that's what this

Time to Charge

During the winter, I've always used a trickle charger to keep my motorhome's battery charged. I discovered that if I put it on a timer so it only ran an hour or two a day, I didn't have to add water every month. Last summer I replaced the battery with a pretty expensive AGM one that doesn't have ports for adding water. I also neglected to use the timer. Now the new battery won't hold a charge or start the motor, and the guy who sold it says I have to buy a charger that costs nearly a hundred dollars to keep it alive over the winter.

A The problem isn't your AGM battery, it's your old-tech charger. It's essentially a constant-voltage device, providing about 14 volts regardless of the battery's state of charge. A really dead battery might pull the output down to a more appropriate 13.2 volts or so, but, ultimately, as the battery charges, the voltage rises and overcharges. With your old-fashioned flooded-cell battery, it wasn't a big deal—as the distilled water was electrolyzed to hydrogen and oxygen and evaporated, you simply topped it off every now and then. Putting the charger on a timer like you did is

Maybe it holds **too much dirt.**



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fellow is trying to sell you at that price; otherwise, look for a device in the \$20 to \$40 range from BatteryMinder, Battery Tender, CTEK or several others.

Shifty ☺ My first car was a 1993 Dodge Daytona, and I now own a 1988 Porsche 944, both with manual transmissions. My dad always taught me to downshift to slow down. He says that I'm saving brakes, and as long as I bring the rpm up before downshifting, I won't harm anything. Is this technique better or more efficient than relying solely on the brakes?

Define "efficient." A skilled driver can match revs and double-clutch a manual gearbox, avoiding premature wear on the synchros and gearsets to achieve smooth deceleration. I do this all the time—but it's not to help out the brakes. I do it to make sure the transmission is in the correct gear for the eventual acceleration.

Mark Donohue (yes, that one, the brilliant race car driver/engineer who drove

for Roger Penske in Trans-Am, Can-Am, IndyCar, Nascar and F1) once told me that brakes are a lot cheaper than engines and transmissions, and that when he needs to slow down, he's not above doing all the braking with his right foot while he skips gears downshifting. I happen to agree with him.

Cracked in Circles ☺ I have a 1997 Honda Accord with 144,000 miles on the clock that's in excellent condition. I intend to keep it for another 100,000 miles. There's about a 1-inch circular crack near the base of cylinder No. 2 exhaust manifold where it joins the exhaust port. Is there a repair method for a cracked manifold, please?

You've neglected to tell me whether your Accord has the four-cylinder or V6 engine: The four-banger has a fabricated manifold welded to steel flanges, while the V6 manifolds are cast-iron. Actually, it doesn't matter: Buy new parts instead of trying to fix them.

I have repeatedly attempted to repair cracked exhaust manifolds, generally with middling success. Welding cast iron is tricky. It requires a skillful welder who has experience welding cast iron, and careful preheating and after-cooling of the manifold. Similarly, properly welding the stamped-steel manifolds is difficult, because years of exhaust gases have contaminated the metal to the point where getting a good bead along the crack will be difficult. Regardless of the material they're made from, repeated heating and cooling cycles have made the metal brittle. If you elect to try welding, this means removing the manifold from the vehicle. There is often enough distortion introduced by the welding that the nearby sealing flange will need to be remachined to seal properly. And odds are that one of the other runners will crack soon after you get the whole thing back together—don't ask how I know.

If you need to remove the manifold to do all this—which is not that simple, as the bolts invariably are difficult to remove—you might as well put on a new manifold. The list price at the Honda dealer is around \$290, but one can be had on the aftermarket for about half that.

Size Matters ☺ My car is a 2005 Cadillac STS. It has P235/50R-17-size tires on front and P255/45R-17 on back. Can I put front-size tires on all four wheels? Is that safe? Will they fit on the wheels? Any adverse effect on handling?

Yes. No. Yes. And, oh, yes.

Changing the tire size will have, umm, unpredictable effects on the car's handling. Your car's spring, shock and antiroll bar rates were tuned for a specific tire diameter and sidewall compliance. Tinker at your peril. I predict extra oversteer, in spite of the yaw control system.

I know I'm going to get letters from hundreds of readers who have done similar swaps without perceived ill effects. I don't care.

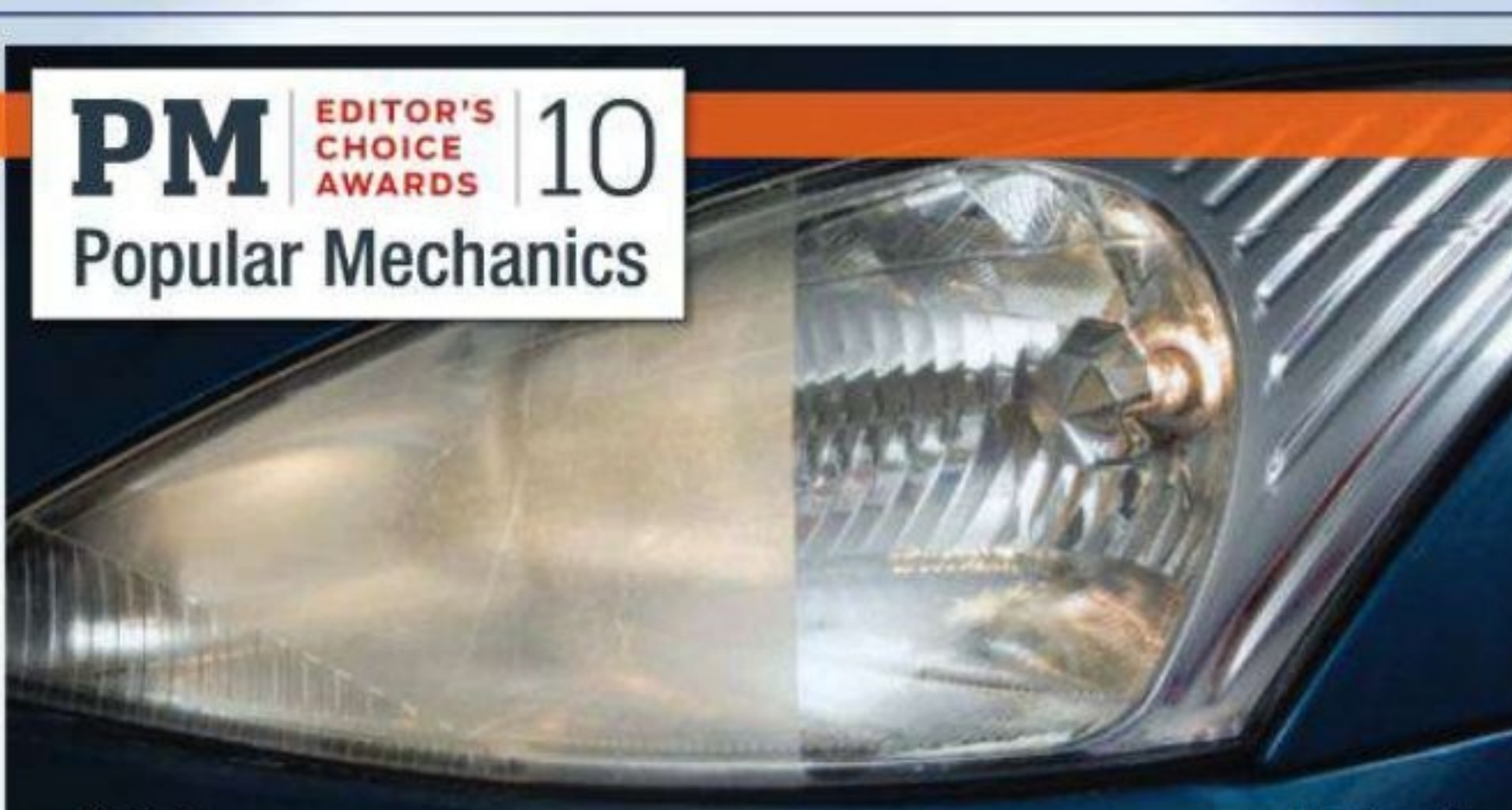
Uplifting ☺ In regard to "Running on Empty," in April's Car Clinic, I have an easier solution for replacing the fuel-tank sender/fuel pump combo. I

PM

EDITOR'S CHOICE AWARDS

10

Popular Mechanics



Before

Restored

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have a 1999 Silverado half-ton pickup. A couple of years ago I encountered the same problem—an erratic fuel gauge. It would have been nearly \$800 to have a shop replace the pump and sender. Instead, I bought the pump and installed it myself. However, I didn't have to remove the tank. Because it is a truck, you can simply remove the bed by taking out six or eight bolts, unplugging the taillights and removing the gas-filler neck. All in all, it took less than a couple of hours, and I didn't have to hoist the truck up like you would when removing the tank.

Actually, you don't even have to completely remove the bed, just tilt it forward enough to get access to the tank. Be careful not to let the bed bash in the back of the cab. And you'll need an overhead winch or a half-dozen stout friends to lift the bed clear. Prop it up carefully so you don't get squashed while working under there.

Inconsistent ☺ I have a 1994 Sierra with 65,000 miles. For the longest time I always got 22 mpg. Now there are days when I get 22 mpg, and there are days when I get 4 mpg. Here's the deal: I travel the same route to work four days a week. The route is all highway, traveled over 60 mph. I've replaced the air filter, the coolant-temperature sensor, the oxygen sensor and the PCV valve. The Check Engine light is not on. On the days when I get only around 4 mpg, it feels like the ignition timing is retarded. I have taken it to a couple of mechanics, and no one can find anything wrong with it. What's my next step?

Your vehicle is pre-OBD-II (On-Board Diagnostics level II), which GM—and the rest of the industry—switched to in

1996 or so. You'll need to consult a mechanic with a scan tool that supports your vehicle, one that interfaces with the older 12-pin ALDL (Assembly Line Diagnostic Link) plug your truck uses. OBD-II-compliant vehicles use a 16-pin plug. The factory GM scan tool of that era was a Tech 1, but there are plenty of other scan tools that will work.

Now, as soon as your truck starts to drive like the timing is retarded, drive to the repair shop and have the mechanic plug in the scan tool. From its display, he'll be able to read the actual spark

advance, the mixture ratio and the output of all of the computer sensors—while the truck's not working properly.

It's pointless to take it to him when all is well, of course. Maybe you can get him to let you drive around or go home some evening with the scan tool connected. A decent tool will have a "flight recorder" mode that takes a snapshot of the engine parameters.

Personally, my off-the-top-of-my-head guess is a loose baffle in the muffler or catalytic converter intermittently partially plugging the exhaust. **PM**



Got a car problem? Ask Mike about it. Send your questions to pmautoclinic@hearst.com or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.



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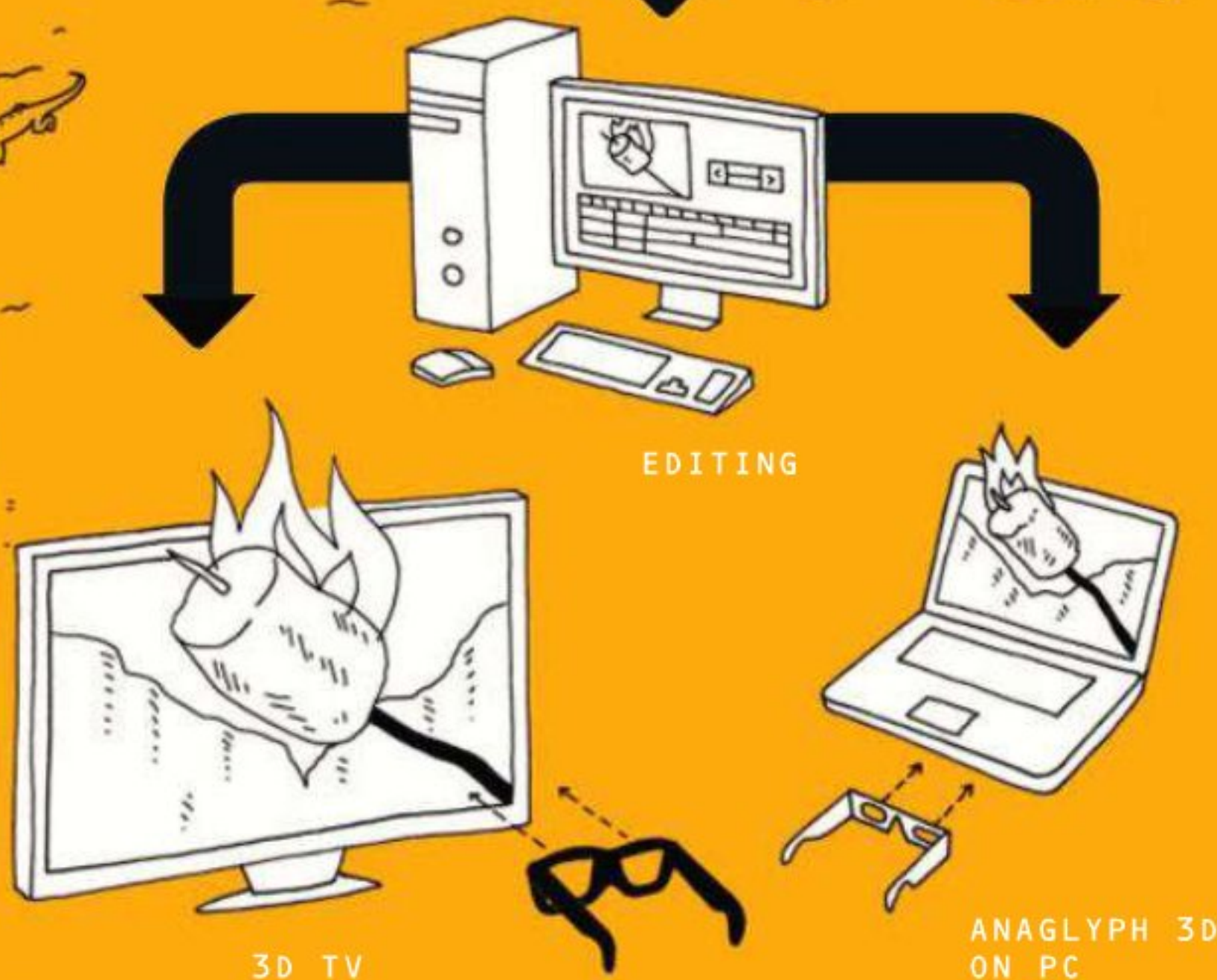
Tech

Making
3D Movies

STEREOSCOPIC VIDEO CAMERAS ARE AVAILABLE AND SURPRISINGLY AFFORDABLE. WHAT DOES IT TAKE TO CREATE YOUR OWN 3D EPIC? BY JOHN HERRMAN



ONSCREEN 3D VIEWING

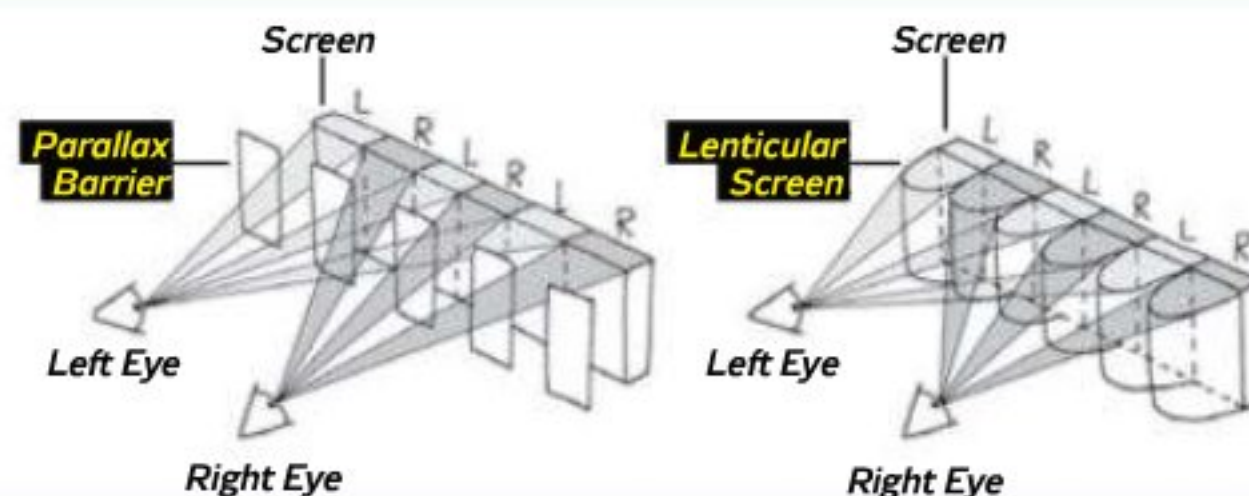


➔ Should everything be in 3D?

Electronics companies sure think so. Over the past three years 3D-capable computers and Blu-ray players and HDTVs with stereoscopic screens have been pitched to consumers. It's a formula that has proved profitable in theaters—for many blockbuster films, moviegoers have gladly plunked down a few extra bucks and donned a pair of glasses in exchange for a jaw-dropping spectacle. When it comes to investing in expensive new gear to bring that experience into the living room, however, most viewers have been hesitant.

But there's one category of 3D gear for the home that doesn't require a bank loan: 3D video cameras. I'm not talking about James Cameron's Pace camera rigs here; these are ordinary consumer-grade camcorders

GLASSES-FREE 3D ➔ There are two technologies used for autostereoscopic screens. Lenticular screens use a layer of miniature lenses, or lenticules, to refract light from different pixels to the left and right eyes. Parallax barrier screens use a layer above the screen with precisely positioned slits that allow each eye to see only certain pixels. The technology is also used in automobile displays to send separate content to the driver and the front passenger.



INSIDE

HOTEL TV SERVICE + FREE INTERNET TEXTING

that are affordable and as easy to use as run-of-the-mill video cameras. They are a surprisingly accessible first step into 3D video. Sure, you'd ideally have a big 3D TV and glasses to watch your creations, but they're not strictly necessary. You can see the video—in 3D and without glasses—on the cameras' own displays.

It's no accident that some of these cameras' manufacturers are also selling 3D TVs—they are banking on user-generated content partially filling the void until Hollywood produces more 3D Blu-rays. And that strategy may work: There are already subcultures of 3D enthusiasts shooting everything from homemade 3D nature clips to 3D music videos and distributing them online.

As for the cameras themselves, there are several coming to market at prices from a few hundred bucks to just under two thousand. I've tried several, and the experience is surprisingly fun—until it isn't. The rough patches have more to do with the half-evolved infrastructure of at-home 3D equipment and software than with the cameras themselves.

The Cameras

➔ **Pricewise, 3D cameras** fall into two categories: For \$1000 to \$1700, you can get a full-feature 3D HD camcorder with optical zoom, high-end sensors and processors that can record at high bit rates—which translate directly to higher video quality. These are available from camcorder stalwarts such as Sony, JVC and Panasonic. Below \$1000, there are several easy-to-use 3D video cameras, but what you get varies from device to device.

The most straightforward of the cheaper bunch is the Sony 3D Bloggie, a camera that resembles the once popular but now defunct Flip video camera, but with two stereoscopic lenses. Primarily a 3D video camera, it can shoot 3D stills as well. Reversing those priorities is the Fujifilm FinePix Real 3D W3, a 3D still camera that can also shoot 3D video. Perhaps the weirdest device in the group is the HTC Evo 3D, a full-feature smartphone with integrated

3D camera that takes both still photos and video. If the \$1000-and-above 3D camcorders are analogous to SLR still cameras, then these more affordable cameras are comparable to pocket point-and-shooters.

Shooting in 3D

➔ **The most obvious outward sign** that you are using a 3D camera is the dual lenses. On the higher-end cameras, this usually results in a heavy lens array protruding from the front of the camera; on the less expensive point-and-shoots, the lenses are built into the camera body. If you're willing to get all sophisticated with your 3D cinematography, some of these cameras allow you to manually adjust parallax settings (by either digitally or physically changing the distance between lenses), which increases or decreases the 3D effect. But for everyday home movies, there's not a tremendous difference between the shooting technique for 2D and 3D video. What *is* different is the way you view your footage. Almost all of these 3D video cameras are equipped with autostereoscopic screens, which let users view 3D images without the need for glasses, even while recording.

To achieve this, most cameras use lenticular screens, which have a thin film of small lenses, or lenticules, to direct the two versions of the video—the left and right perspectives—to each of the viewer's eyes. JVC's GS-TD1 and HTC's Evo 3D use slightly different technology—a parallax barrier screen—for their "glasses-free" 3D: A

EQUIPMENT 3D VIDEO CAMERAS BY THE NUMBERS



System	JVC GS-TD1	SONY HDR-TD10	PANASONIC HDC-SD800
Cost	\$1700	\$1500	\$1200 (with 3D-lens attachment)
Zoom	5x optical (3D), 10x optical (2D); 100x digital	10x optical (3D), 12x optical (2D); 160x digital	20x optical; 700x digital
Sensors	Twin 3.3 megapixels	Twin 2 megapixels	Triple 3.05 megapixels
Max bit rate	34 Mbps	28 Mbps	28 Mbps
Screen	3.5-inch parallax barrier 3D LCD	3.5-inch lenticular 3D LCD	3.0-inch 2D LCD



System	FUJIFILM FINEPIX REAL 3D W3	SONY MHS-FS3 3D BLOGGIE HD	HTC EVO 3D
Cost	\$450	\$250	Price not set
Zoom	3x optical	4x digital	4x digital
Sensors	Twin 10 megapixels	Triple 3.05 megapixels	Twin 5 megapixels
Max bit rate	Not specified	Not specified	6 Mbps
Screen	3.5-inch lenticular 3D LCD	2.4-inch parallax barrier 3D LCD	4.3-inch parallax barrier 3D LCD

filter with precisely positioned slits occludes pixels intended for the left eye from the right eye, and vice versa.

Both technologies work surprisingly well. The Fuji W3's 3.5-inch screen elicited *oohs* and *ahs* from everyone I showed it to, and conveyed remarkable depth in spite of its modest size. But extended use revealed its shortcomings. These displays are temperamental, and viewers' eyes need to stay in a narrowly determined area for the effect to work. Moving an inch to the side or tilting the screen a few degrees can turn the image into a fragmented mess or a dark blur; showing it to others basically requires you to give them a crash course in autostereoscopy. And even a well-adjusted screen strains the eyes with sustained use. A poorly adjusted screen? Instant headache. Plus, none of these manufacturers has created 3D menus, so the onscreen information gets layered over the 3D image in a way that destroys the effect and can unsettle the stomach.

Big-Screen Options

➔ **Truly enjoying 3D video** means sending it to a larger display. Unfortunately, as soon as 3D footage leaves the camera, things start to get complicated.

Most of the new generation of 3D cameras are equipped with HDMI outputs, which let them connect directly to any 3D HDTV. To view your video and photos on the big screen, however, requires using your set's 3D active-shutter or polarized glasses. On a modern 3D HDTV, the resulting effect is profound, albeit limited: Vividly defined subjects—nearby people, layered vegetation, a closely passing car—will contrast with their backgrounds with distinct depth, producing a sensation remarkably close to that of viewing a big-budget 3D film in a theater.

There are some peculiarities. When viewed on a big screen, shots I took of Lower Manhattan from across the East River conveyed disappointingly little depth. Footage I took of friends playing soccer against the backdrop of a wide-open park left them looking flat, giving the scene a paper-cutout aesthetic. (Though, to be fair, this problem was more pronounced on some 3D displays than others.) Filming from too short a distance forces parts of the frame out of focus, breaking the 3D illusion entirely.

Then there's the image-quality issue. Many of these cameras can capture 3D in HD, but the video quality is noticeably lower than full HD when displayed on TV, a consequence of the two video streams being stored side by side in the same HD video file.

Editing and Sharing

➔ **Like most cameras**, these 3D shooters ship with PC software capable of performing light editing work. These simple programs are focused on cutting and sharing, so for serious home moviemaking, something more powerful is required. So far, neither of the operating systems' freebie movie editors—Windows Live Movie Maker and Apple's iMovie—supports 3D, which means you'll need an editing suite such as Roxio Creator or Magix Movie Edit Pro (each retails for less than \$100) for fancy

effects like 3D fades and titles or for burning your masterpiece to a DVD. (For the time being, recording your own 3D Blu-ray discs is out of the question.)

Like TVs, few computers are set up for 3D duty. To display 3D natively with a PC, you need serious graphics horsepower, a special high-refresh screen and active-shutter glasses. Sharing your videos presents a new set of challenges—it's unlikely that Grandma has a 3D TV or computer available to watch Junior's first stereoscopic steps. But YouTube has a dedicated 3D channel that offers some innovative work-arounds. The site lets users upload split-frame, side-by-side 3D video. Then users can choose one of three ways to watch it. If you do, indeed, have a 3D-capable monitor, YouTube will output the side-by-side video and let your equipment interpret it. The site's bicolor anaglyph mode preserves the 3D effect and can be viewed with any old pair of red-and-blue cardboard 3D glasses, but it severely tints the video's colors. YouTube also has a Cross-eyed display option that requires no glasses at all, just some eyeball gymnastics. It produces decent results, but the drawbacks are as painful as they are self-evident. Asking someone to do this for more than a minute is a good way to make them despise 3D forever. So, there are plenty of options for 3D viewing, even if none of them is perfect. But there's one more nice aspect to 3D video—if you don't feel like watching your videos in 3D, you can always remove one of the stereoscopic views and, *voilà*, the world is comfortably flat all over again. **PM**

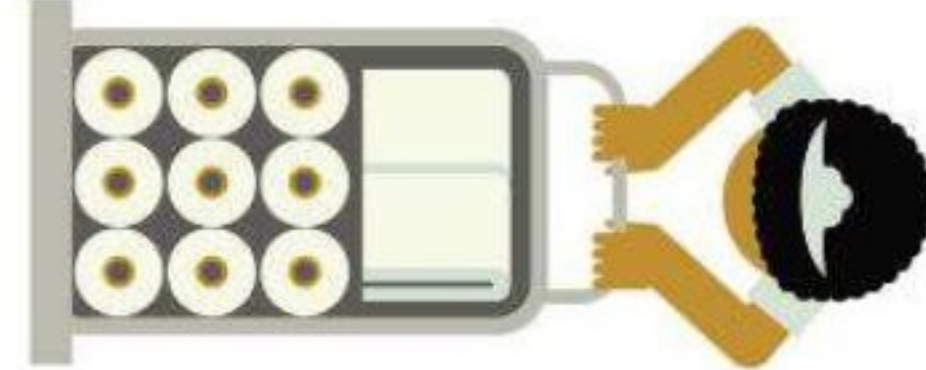
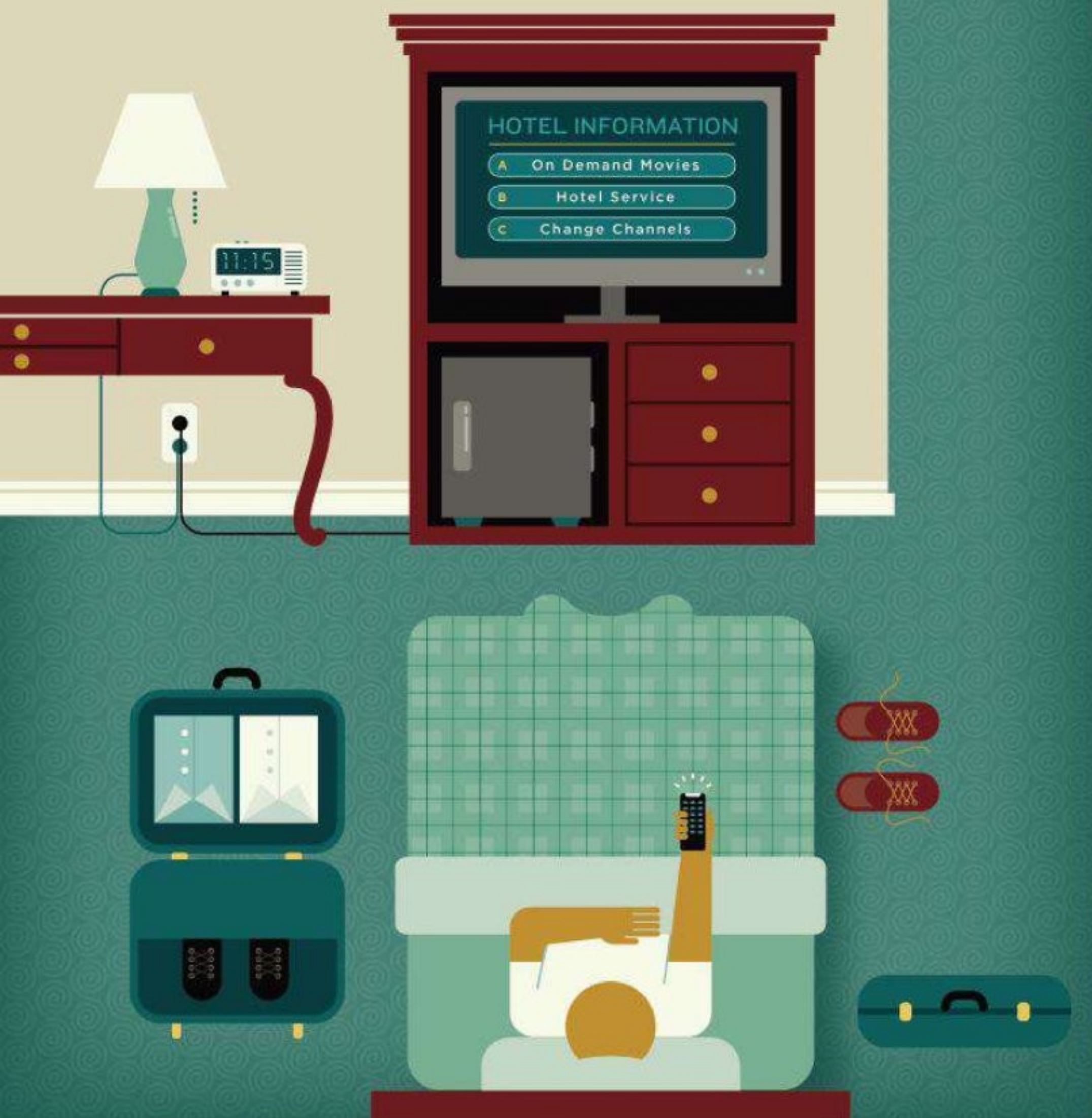


FINISH LINE

Digital Clinic

by Seth Porges

Q+A



hotel restaurants and amenities or pushes the latest pay-per-view offerings can make the place more money. And the missing onscreen TV guide? Well, I figured someone was hedging against the possibility that knowing the original *Die Hard* was showing on TNT might make a viewer think twice about shelling out cash for *Battle: Los Angeles* on PPV.

While there turned out to be some truth to my musings, the situation is actually more complex. Hotels typically rely on specialized television providers that have built their businesses around catering to hotels' needs. Most consumers have never heard of these vendors, which go by names such as LodgeNet and Cox Hospitality Network, but they are big deals in the travel industry. These services are definitely designed to turn TVs into a cash pipeline through their information channels and PPV offerings, but most hotels get only 10 to 15 percent of a PPV film's revenue, according to a LodgeNet rep.

The other service the vendors supply is a set of solutions to logistical challenges. For example, your home cable system likely requires a connection between a decoder box and each and every TV.

Filling a massive Marriott with hundreds of these boxes would be expensive and leave the system vulnerable to thieves looking to graduate beyond bathrobes and mini shampoo bottles. And when a box died, the hotel would have to send a technician up to the room, which would mean additional

Q The Problem With Hotel TVs

I've noticed that the TV service at pretty much every hotel I've stayed at in recent years is miles behind my home cable TV setup. What the heck is going on here?

A Hotel TV systems are a constant pain point for frequent travelers. A partial checklist of complaints I've heard (and, frankly, voiced): There is rarely an interactive onscreen channel guide, every time the TV is turned on it resets to an information channel (with the volume jacked up), and it can take a second or more for the TV to change from one channel to the other.

So why don't hotels just use regular cable services? Like many disgruntled consumers, I long assumed it was all part of a carefully crafted cash grab. After all, it isn't difficult to see how resetting the station to an information screen that advertises

costs, plus irritation for guests.

Instead, hotel cable systems usually work by hooking up each room's TV to a central stack of decoder boxes located somewhere in the complex. "The basement or top floor is the most likely place, but in reality it is simply any location with climate control, power and access to the cable infrastructure," says John Fountain Jr., director of network technology at Cox Hospitality Network. Each box in the stack stays tuned to a particular channel. So, when a guest surfs to ESPN, for example, his TV is tapping into a dedicated decoder box that is always playing that one channel. I was surprised to learn that the actual TV feed usually comes from the same satellite and cable providers that service local residences.

On-demand and PPV programs work a bit differently. Typically, the TVs tap into a central server—again, situated in the hotel—that holds all of the current PPV offerings, stored on either a digital file server, optical discs or, in some cases, VHS tapes (seriously!). For example, Cox updates its PPV offerings by dispatching movie-toting reps to the individual hotels, while LodgeNet uses a private satellite network to remotely send the new movies.

Okay, so we know why hotels use different cable services. But that still doesn't explain why these services work so badly from a user's point of view. Here are some answers, point by point.

→ **The cranked-up volume.** Hotels often use what are known as commercial-grade hospitality TVs. The main benefit

of these sets is a group of copy protection features that Hollywood studios require as part of their PPV deals. The TVs also give their owners the option of defaulting the volume to a particular level every time they're turned on. Unfortunately, many hotels seem to overestimate the volume level needed to get your attention.

→ **The slow channel-change.** Yes, hotel TVs usually have a slight delay when you change the channel, but, according to the hotel chains and television providers I spoke with, this is actually an unavoidable byproduct of digital television and is no worse in hotels than at home. It might just seem worse because, in an era of onscreen interactive menus, people rarely manually surf through stations on their home TVs.

→ **The lack of interactive programming guides.** Most hotel TV services offer resorts various tiers of television service, some including interactive onscreen channel guides. Unfortunately, you're just more likely to find a hotel room without one of these at this point.

So, could hotel TV services be better? Undoubtedly. And while it's reassuring to know that there's a reason behind all of their shortcomings, the only way these things are going to improve is if you let hotels know that you expect more. Maybe then they'll splurge on the interactive channel guide option. And until then, there's always that paper printout of channel listings by the TV. View it as an interactive analog channel guide.

Service-Free Texts ➔ **My office building has tons of cellphone dead spots but fairly solid Wi-Fi. Can I send text messages over Wi-Fi if I don't have any cell service?**

No and yes. SMS text messages may seem more like bits of data than voice calls, but they still require a link to cell towers to make it through.

That being said, there are many ways to send SMS messages over Wi-Fi. You can email them to your friend's phone number. (Do a Google search to find the proper way of transforming any phone number into an email address, as it varies depending on which mobile carrier the recipient uses.) And if you have a smartphone, there are multiple text-delivering websites and apps that can work over Wi-Fi. These apps are typically designed to give you a way to send texts for free, but they can also come in handy for reaching out from dead zones.

Unfortunately, it's a bit tougher to receive texts without cell service. One solution I like: If you use Google Voice, you can set your account to forward all text messages to your email. As a bonus, you can respond via text by simply replying to these emails. **PM**

Got a technology problem?

Ask us about it.

Send your questions to pmdigitalclinic@hearst.com.

While we cannot answer questions individually, problems of general interest will be discussed in the column.



BOTTOM LINE

made good money. Then Jim Burnett, Western Enterprises' owner, offered something Caimano had long wanted: creative control, plus a factory capable of making any effect he dreamed up.

In 1998, Caimano moved his wife and kids to Carrier, population 78. "I'm surrounded by explosives every day," he says. "It's magical."

Instead of stitching together punch posts with a musical medley at La Ronde, Caimano will play 12 entire songs, letting the emotional rise and fall of each one carry the show. "I've always believed in subtlety," he says. "My idea is to do as much as I can with as little as I can use."

Western's show might look great. Or it might seem like a skinny teenager swimming around in his father's shirt.

"Gary's show is very clever," blogger Marriott says. "Maybe too clever."

A semi delivers Western's shells three days before showtime. Burnett, who's 62, pulls on gloves and starts dropping shells into mortars in the noontime heat. La Ronde's fireworks and entertainment technical director, Paul Csukassy, works alongside the best fireworks teams in the world. "These guys are different," he says. "They're really passionate."

IT IS THE DAY BEFORE the show, and Caimano is 1 second late. He's been 1 second late for 3 hours. Now all of his cigarette smoking and pacing have come down to this moment. He's standing clenched and still, glaring at a metal box.

"I'm trying to stay patient," Caimano says, "but I'm about to lose my cool."

The box is a brand-new, Chinese-made computer called PyroSeeking. Switching firing computers at the last minute is a big risk, one that most technicians would never take. But Caimano needs to launch every shell from multiple sites exactly on time, so he's gambled on the most advanced model he could rent.

PyroSeeking should be a safe bet: It is so precise that it times each bomb's ignition to $\frac{1}{100}$ of a second. Unfortunately, the computer keeps firing cues precisely 1 second after the beat.

"This is why you don't do something new at the last minute," Csukassy says. "You do what works."

Outside the control room, the crew

loading shells bogs down in the heat. Gilberto Mora, who works in the factory at Western, wipes his forehead with the sleeve of his T-shirt—cotton, so that it can't produce a spark. Before long, thunder rumbles, and everyone looks up. Then the sky opens. Mora sprints for cover. Rain can short the computer's firing systems. Also, the close-proximity shells—currently covered with plastic—are packed in cardboard tubes; if they get wet, they won't light.

"It's a torrent! A literal torrent!" Burnett says, wiping the rain off his face with his open palm as he steps into the trailer. "Golly. What a mess."

Meanwhile, Caimano finally knows why PyroSeeking is late. Instead of beginning the count at one, like European machines, the Chinese computer starts at zero. Jamie Deye, who runs the firing system, compensates by moving the entire soundtrack back 1 second. "It's on the mark! Just burn the damn thing [on a CD] right now!" Caimano yells.

Csukassy shakes his head and snorts a laugh. "Tomorrow should be a good day," he says. "Except maybe the weather."

ON THE RIDE BACK to La Ronde the following afternoon, the sky is black with rain. Caimano, Burnett and the rest of the Western team glumly watch the water pour down the van windows.

Finally, it lets up. The Americans run through a back gate and into the amusement park. The local crew reports that the ramps took a direct lightning strike, maybe two. Nobody knows how many fireworks were lost.

Thirty minutes before showtime, people begin pouring into the grandstands. Csukassy walks over to Caimano with a walkie-talkie. It's decision time: Remove the plastic? The big aerial fireworks can shoot through it—but not the close-proximity shells, which make up two-fifths of Western's show. To fill this enormous canvas, to win, Caimano

TO FILL THIS ENORMOUS CANVAS, TO WIN, CAIMANO NEEDS THOSE FIREWORKS. BUT REMOVING THE PLASTIC WILL LEAVE WESTERN'S BEAUTIFUL SHELLS VULNERABLE TO RAIN.

needs those fireworks. But exposing them will leave Western's beautiful shells vulnerable should the rain return.

At the last possible moment, he gives the order: Remove the plastic.

Breathing loudly, Caimano climbs the stairs behind the grandstand and enters the control room. Over the speakers, the announcer counts down in French.

"Somewhere a place for us," Barbra Streisand sings, and the computer fires 10 purple comets with golden tails that rise and swish. The sound builds into a wall of bass, Streisand's voice soars, and the whole sky explodes. White close-proximity shells *foosh!* from the ground, then turn green. In that split second before Streisand pops the "p" on "place for us," two big aerials burst high and bathe the audience in mint-green light. People in the grandstand smile and *whooo!*

Caimano's got them. He stands in the open window and wipes sweat from his face with a wet towel. A raindrop hits his forehead. And another. Soon it becomes a drizzle. Then a downpour.

The misfire starts small: A few green and red strobes on Ramp 3 scream sideways. Before long, one-tenth of the fireworks on Ramp 2 are underwater. Nearly 200 shells can't fire.

The Americans will not win this competition. Caimano knows that. But he may have enough fireworks left to put on one hell of a show. Roger Daltrey belts "Love, Reign O'er Me," the Who's great power ballad. Little shells burst to create the shapes of hearts. Then the computer launches everything it's got. Blue shells stretch over the lake, clawing at the crowds. A white tower rises into the sky and connects to a hammering mass of blue and red stars before it all morphs into a thundering mushroom cloud.

The boom of exploding shells recedes. The rain is gone. As the crowd stands to cheer, Caimano looks around and smiles. "What did I tell ya?" he yells. "I said we were gonna make the sky move!" **PM**

Lessons From Japan

(CONTINUED FROM PAGE 91)

ideas seem expensive but prudent. But some experts worry that massive seawalls breed complacency and sap the will to be prepared.

"Projects worth trillions of dollars, with sophisticated infrastructure, are more attractive to policymakers than invisible options such as . . . strengthening community awareness," says Jonatan Lassa, who studies disaster risk mitigation at Harvard Kennedy School. "Engineering measures can reduce regular risks, such as cyclones and floods, but may not always protect people from the extremes." Rikuzentakata's seawalls stood 20 feet high; the tsunami was twice that. Only education can prepare people for the worst.

"Tsunami preparation is about cultural behavior," Corcoran says. "Give me \$1.5 billion and I'll personally talk to every person along the Oregon coast, and they'll know where to go to higher ground."

• •

Any serious discussions about disaster preparedness must balance the cost of protection against the chance of a catastrophe happening. "How much insurance do you want to buy?" Berkeley's Stojadinovic says.

The answer depends on the level of risk. Geologists detect about 40 small earthquakes each year in the northeastern U.S., but the region's build-

ings have little seismic protection. That's because the likely frequency of a 7.0 quake hitting the eastern U.S. is about one every 500 years. Our society has decided to accept the long odds and not spend the money to guard against this low-probability event. But that choice may come with a price: A modest earthquake in the Northeast could cause more damage than a huge one in better-prepared California.

No matter where you live, Tanaka's experience may offer the best, most cost-effective lesson: Be prepared. "The single greatest thing people can do is to understand that they will have to take care of themselves," says Mike Martinet, until recently the executive director of the Office of Disaster Management for 14 cities in the South Bay region of Los Angeles County.

"There are about 3000 paramedics in greater Los Angeles, a city of 10 million people," Martinet says. "There just isn't enough government to take care of that many people, especially

when roads and communications stop working."

The night of the tsunami, Tanaka distributed caramel sea salt brownies from her purse to fellow survivors. They endured snow in a shelter made from a bedsheet thrown to her by survivors atop a nearby hospital.

Nine days later, Tanaka was no longer a victim. Instead of heading back to Los Angeles, she was serving as a translator and guide for a team of Dutch volunteers and their cadaver dogs, searching the wreckage of her hometown for bodies. "I had to do something for my community," she says. "I just had an urge that I had to help them out."

Tanaka and her aunt are alive because she remembered what to do without panicking and acted quickly. Because of that, she's now able to help others. **PM**

ADDITIONAL REPORTING BY
SARAH FECHT AND ALYSON SHEPPARD

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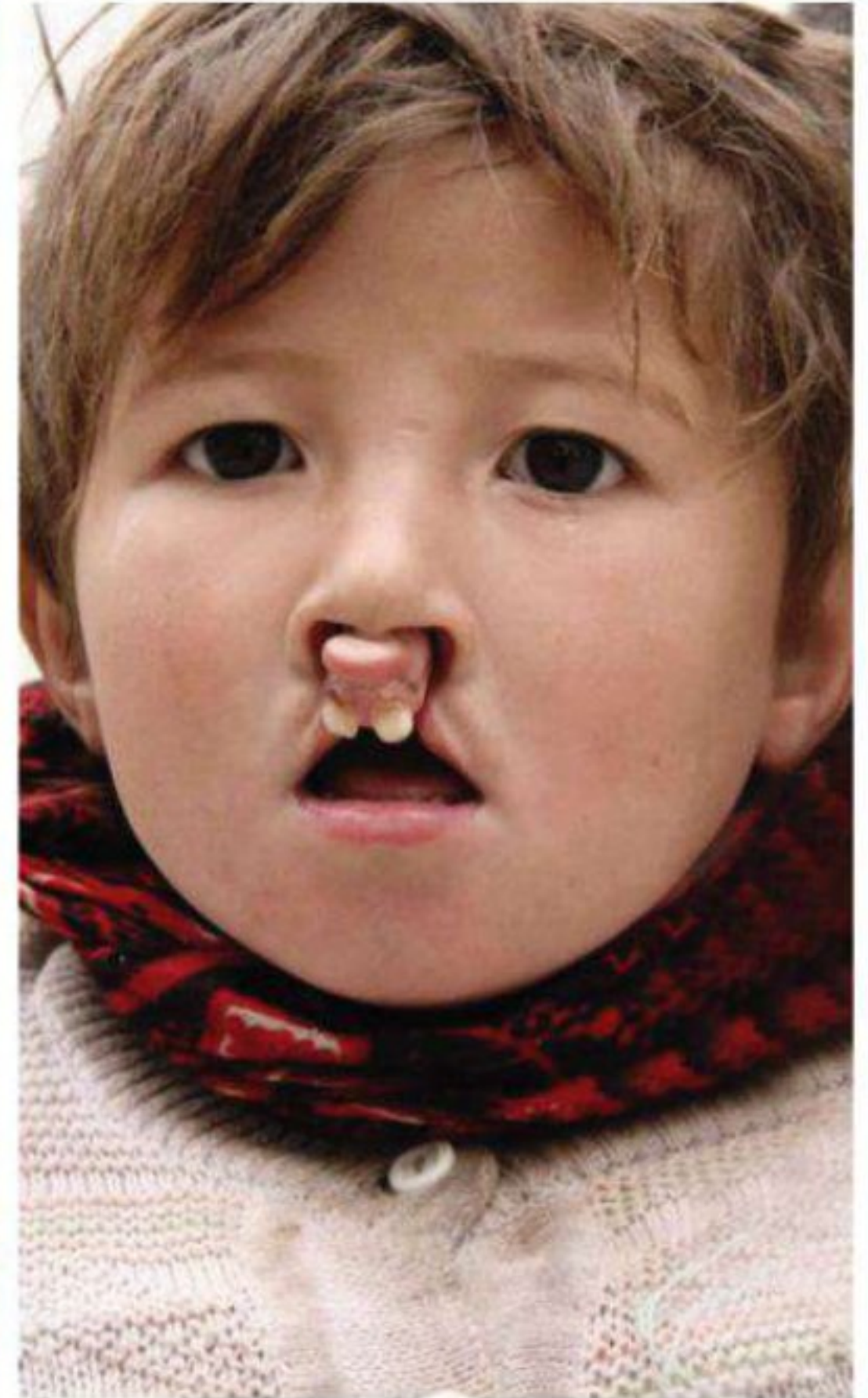
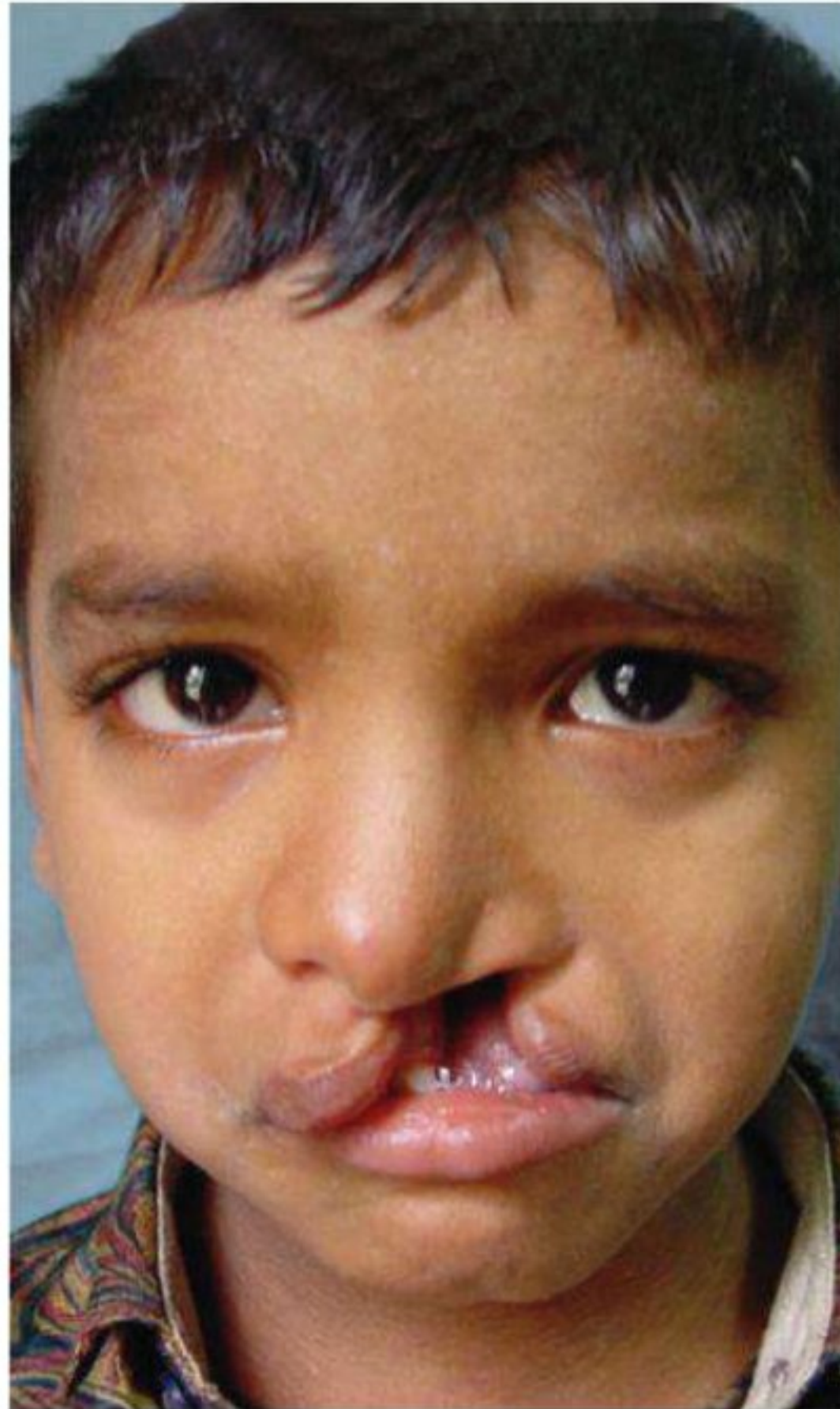
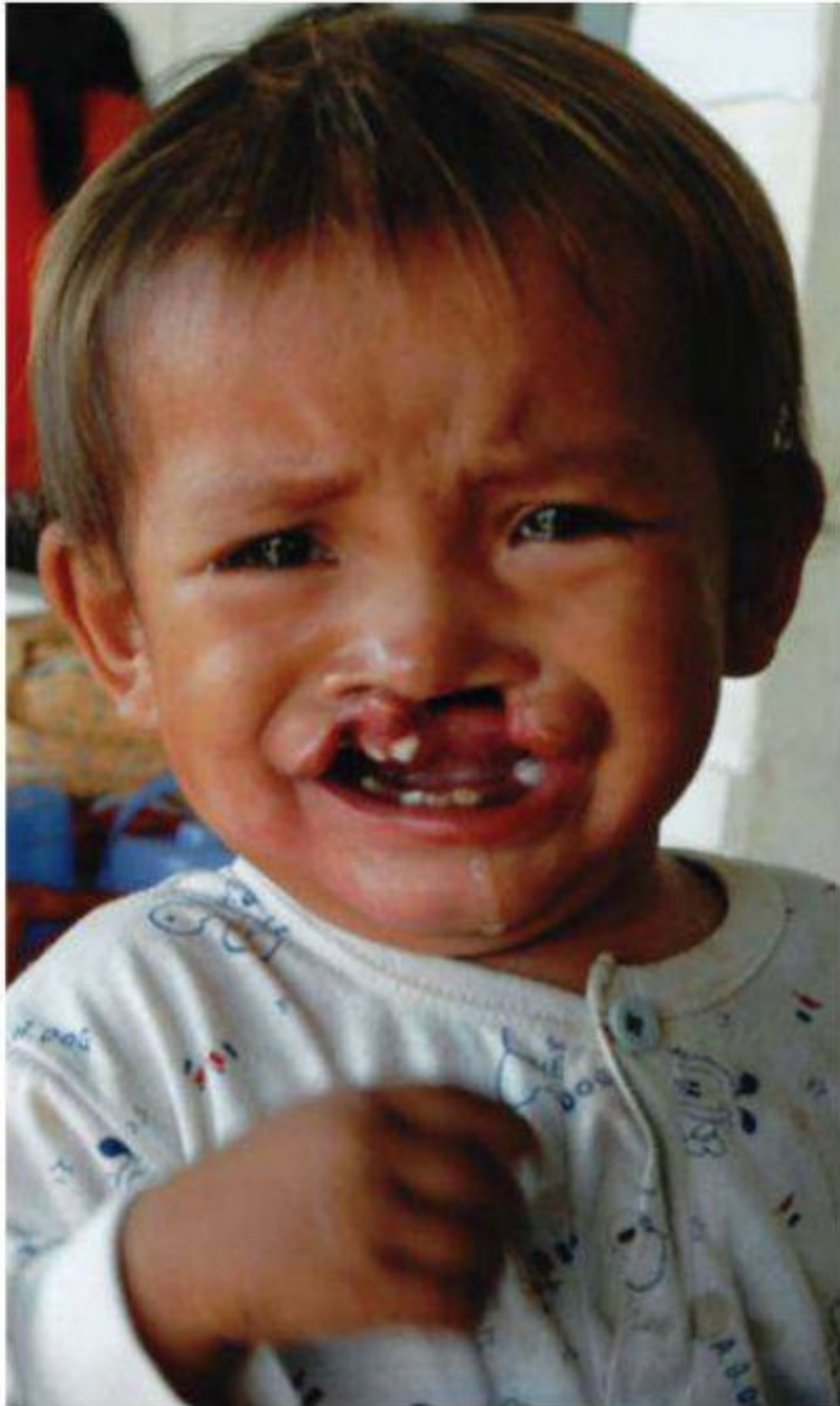
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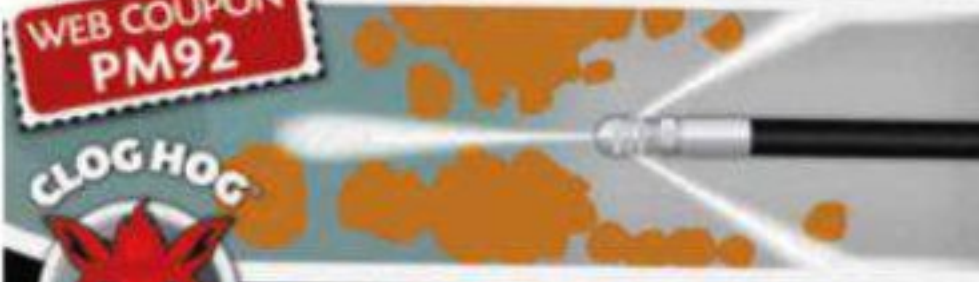
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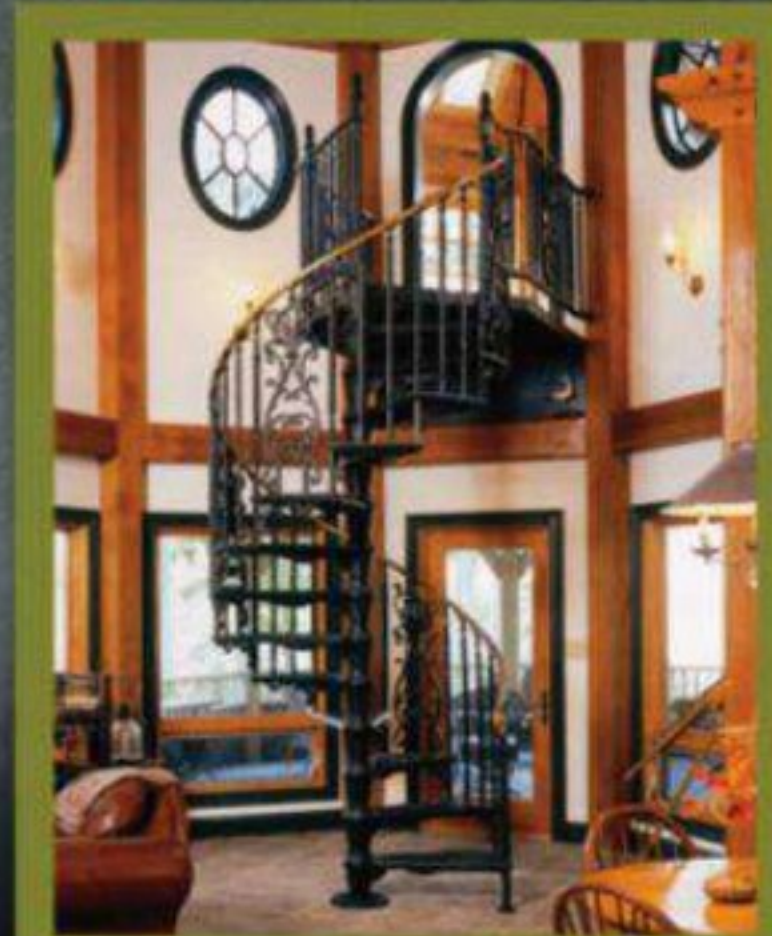
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This Is My Job



HOW IT WORKS: FRAME-BUILDING

1. MITERING

To cut the steel, titanium and carbon-fiber tubes that fit together in bike frames, Strong uses a hand-me-down vertical milling machine. Once he places a tube in a vise and sets it at the desired angle, Strong slices through it to create a coped end.

2. SHAPING

Strong shapes cylindrical parts like the head tube—which connects the fork holding the front wheel to the frame—on a 9-inch lathe. As the tube rotates, he sculpts it thinner at the front for reduced weight and thicker at the back for welding stability.

3. TACKING

Next, Strong places the components in a tacking fixture, which holds the parts in relation to one another so he can fine-tune their fit. The tool is flexible enough that he can remove and reload a tack-welded frame without disturbing the setting. "Larger tools are designed for production runs, so they're hard to change," Strong says. "This one was created with guys like me in mind, where every frame we build is different." To ensure accuracy, he checks each tack-welded frame against a steel alignment plate.

4. ASSEMBLING

When it's time to permanently join the tubes, Strong uses a tungsten inert gas (TIG) welder (left). "Anytime you're trying to optimize strength and minimize weight in assembly, TIG is the best option," he says. Argon gas shields the piece Strong is welding so outside air never touches it, protecting the weld from impurities that can cause contamination and producing a more resilient bond. This allows him to use less material for the frame.

× BIKE BUILDER

Name: CARL STRONG

Location: BOZEMAN, MONT.

Age: 46

Years on Job: 18

× **When Carl Strong opened** a retail store in 2002 to expand his presence in the local bicycle market, he realized quickly that it was a mistake. "I learned that I didn't want to manage people," he says. "What I wanted to do was build frames." The Seattle transplant now focuses on his true passion—working with chrome moly, titanium and carbon fiber. Strong custom-designs each bike to fit a client's body and biking goals: long road trips or fast, short races, for example. He constructs 90 frames a year. "I consider myself a craftsman foremost," he says. "I want a frame to look good, but I never do any adornment that doesn't add to the bike's performance." — LAURA KINIRY



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